ENGINEERING CHANGE NOTICE

Page 1 of 2

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Proj. ECN

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16. Design Verification Required	17. Cost Impact							18. Schedule Impact (days)	
	ENGINEERING			CONSTRUCTION					
☐ Yes	Additional	☐	$	Additional	☐	$		Improvement	☐
☒ No	Savings	☐	$	Savings	☐	$		Delay	☐

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	Other	☒
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority		1-30-97	Design Agent		
Cog. Eng. R. D. Claghorn		2-3-97	PE		
Cog. Mgr. J. S. Garfield	John S. Garfield		QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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

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Key Words: Alternatives Generation and Analysis, AGA, System Design Requirements

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-shell 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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(2) Title

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

CHANGE CONTROL RECORD

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HNF-SD-TWR-AGA-001
Revision 1

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	Sodium 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
Detriment	Cost of exposure
Dilution Factor	The ratio of the staged feed volume to the original volume of the waste before retrieval
DQO	Data Quality Objective
DST(s)	Double-shell tank(s) that contain mixed waste scheduled for retrieval and processing during Phase I Privatization operations at the Hanford 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* Feed Envelope

GLOSSARY

Abbreviation, Acronym, or Term	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
gibbsite	Sodium Aluminate, ($NaAlO_2$)
GOCO	Government Owned / Contractor Operated
HEPA Filter	High-efficiency particulate air filter
Hanford Site	The Department of Energy's nuclear site located North of Richland, Washington
HLW	High-level waste
HVAC	Heating, Ventilation, and Air Conditioning
Insoluble Solids	Metal, metal oxide, and other insoluble compounds insoluble in water or dilute caustic solutions (i.e., sludge)
IWFSS	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 *RFP* Feed Envelope	A set of physical and chemical limits, defined by the *RFP* and by the *LLW Feed Staging Plan*, 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 I	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.
PHMC	Project Hanford Management Contractor
PLC	Programmable Logic Controller
PNNL	Pacific Northwest National Laboratory
Private Contractor(s)	Private companies involved in the Phase I 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 Privatization Request for Proposals* (DOE-RL 1996)
RRSD	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*).
Solids Entrainment	The entrainment of settled solids during retrieval and transfer from the source tanks or transfer from the staging tanks.

GLOSSARY

Abbreviation, Acronym, or Term	Corresponding Term or Definition
Soluble Solids	Solids that can be dissolved in water or 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 LLW 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.
TBD	To Be Determined
TECC	Total Estimated Construction Cost
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
Transuranic Radionuclides	All the isotopes of americium, plutonium, and neptunium.
TRU	See transuranic 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

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-Shell Tank (DST) Waste Retrieval 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 obilization 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 (IWFST) Mixing System (if required), the IWFST Sampling System (if required) and the IWFST 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 ventilation 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

ALTERNATIVES	STUDY INFLUENCE		STUDY SCOPE				
	SOURCE TANK TRANSFER PUMP	WASTE DISSOLUTION AND DILUTION	IWFST TRANSFER PUMP	IWFST VALVE PIT	IWFST MIXING SYSTEM	IWFST VENTILATION SYSTEM	IWFST SAMPLING SYSTEM
1	• NO SOLIDS CONTROL (feed intake pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• SOLIDS CONTROL (decant pump)	•	• NO MIXER	• DO NOTHING	• GRAB SAMPLING
2	• NO SOLIDS CONTROL (feed intake pump)	• DISSOLVE ALL SOLUBLE SOLIDS	SOLIDS CONTROL (decant pump)	•	• PULSED AIR MIXER	• DO NOTHING	• GRAB SAMPLING
3	• NO SOLIDS CONTROL (feed intake pump)	• MINIMUM FOR WASTE TRANSFER	• SOLIDS CONTROL (decant pump)	•	• MIXER PUMP w/ [illegible]	• DO NOTHING	• GRAB SAMPLING
4	• NO SOLIDS CONTROL (feed intake pump)	• MINIMUM FOR WASTE TRANSFER	• SOLIDS CONTROL (decant pump)	•	• MIXER PUMP w/ [illegible]	• DO NOTHING	• GRAB SAMPLING
5	• SOLIDS CONTROL (decant pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• NO SOLIDS CONTROL (feed intake pump)	•	• NO MIXER	• DO NOTHING	• GRAB SAMPLING
6	• SOLIDS CONTROL (decant pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• NO SOLIDS CONTROL (feed intake pump)	•	• PULSED AIR MIXER	• DO NOTHING	• GRAB SAMPLING
7	• SOLIDS CONTROL (decant pump)	• MINIMUM FOR WASTE TRANSFER	• NO SOLIDS CONTROL (feed intake pump)	•	• MIXER PUMP w/ [illegible]	• DO NOTHING	• GRAB SAMPLING
8	• SOLIDS CONTROL (decant pump)	• MINIMUM FOR WASTE TRANSFER	• NO SOLIDS CONTROL (feed intake pump)	•	• MIXER PUMP w/ [illegible]	• DO NOTHING	• GRAB SAMPLING

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

Table 1-1. Intermediate Waste Feed Staging System Alternatives Decision Criteria Matrix.
(Sheet 1 of 2)

Intermediate Waste Feed Staging System Alternatives Decision Criteria Matrix

Decision Criteria	Alternatives[a]					
	3	4	5	6	7	8
Alternative Description	Solids Control at Staging Tank Mixer Pump On Center	Solids Control at Staging Tank Mixer Pump Off Center	Solids Control at Source Tank No Mixer	Solids Control at Source Tank Pulsed Air Mixer	Solids Control at Source Tank Mixer Pump On Center	Solids Control at Source Tank, Mixer Pump Off Center
Capital Cost[b] Operating Cost Life Cycle Cost[b]	$23,000,000 $ 3,860,000 $26,860,000	$21,000,000 $ 3,860,000 $24,860,000	$17,800,000 $ 9,840,000 $27,640,000	$21,100,000 $ 3,860,000 $24,960,000	$27,300,000 $ 3,860,000 $31,160,000	$26,100,000 $ 3,860,000 $29,960,000
Technical Maturity	Available	Available	Under Development The equipment is judged to be available The technical information required to prevent precipitation of solids is judged to be under development.	Under Development The equipment is judged to be available with regards to moving liquids The technical information required to prevent precipitation of solids is judged to be under development.	Available	Available
Maintainability	Medium Maintainability These alternatives do not rank as high as Alternatives 5 and 6 due to additional mechanical equipment. However, the systems associated with these alternatives have been shown to be reliable and the equipment would be readily accessible for repair and maintenance		High Maintainability Least amount of equipment and, therefore, the fewest maintainability issues	High Maintainability The pulsed air mixing system has no moving parts in or around the tanks and therefore, few maintainability issues.	Medium Maintainability These alternatives do not rank as high as Alternatives 5 and 6 due to additional mechanical equipment. However, the systems associated with these alternatives have been shown to be reliable and the equipment would be readily accessible for repair and maintenance	
Safety	High Safety These alternatives rank higher than Alternative 5 due to lower sampling requirements. However, compared with the other alternatives the safety issues would be similar		Medium Safety High operator dose because of additional required sampling.	High Safety These alternatives rank higher than Alternative 5 due to lower sampling requirements. However, compared with the other alternatives the safety issues would be similar		

Table 1-1. Intermediate Waste Feed Staging System Alternatives Decision Criteria Matrix. (Sheet 2 of 2)

Intermediate Waste Feed Staging System Alternatives by Decision Criteria Matrix (Cont.)

Decision Criteria	Alternatives[a]					
	3	4	5	6	7	8
Operability	**Highest Operability** This alternative provides the most robust system to respond to off-normal conditions such as unexpected solids accumulation and/or precipitation. The mixer pump can aid in dissolving insoluble solids and the decant pump can handle solids entrainment.	**High Operability** This alternative is operably the same as Alternative 3 except the off-center mixer pump will be less effective at mobilizing the solids for dissolution or transfer than is alternative 7 which has an on-center pump.	**Low Operability** These alternatives are ranked the lowest in being able to respond to off normal conditions. They do not provide for solids entrainment control in the staging tanks and therefore rely on the DST Waste Transfer System to control the entrainment of insoluble solids at the source tank. These alternatives also do not provide a mixing system in the staging tanks which could be used to mobilize soluble solids to aid in solids dissolution and 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.		**Medium Operability** This alternative does not provide for solids entrainment control in the staging tanks and therefore relies on the DST Waste Transfer System to control the entrainment of insoluble solids at the source tank. A mixing system is provided in the staging tank that can aid in solids dissolution.	**Medium Operability** This alternative is operably the same as alternative 7 except the off-center mixer pump will be less effective at mobilizing the solids for dissolution or transfer than are alternatives 7 which has an on-center pump.
Schedule Impact/Risk	**Low Schedule Impact/Risk** More solids will accumulate in the staging tank in this alternative than in alternatives 7 or 8 and will require more scheduled time between batches for solids mobilization and transfer back to tank farms.	**Medium Schedule Impact/Risk** Solids will accumulate in the staging tank in this alternative just like in Alternative 3 but the off-center mixer pump will be less effective in mobilizing the solids. This will require more scheduled time between batches.	**Highest Schedule Impact/Risk** There is no efficient method for the removal of settled solids in these alternatives. If settled solids accumulate in the staging tank they will reduce the operating volume of the staging tank and may cause schedule milestones to be missed.		**Low Schedule Impact/Risk** Solids will accumulate in the staging tanks in this alternative but the on-center mixer pump should be effective in mobilizing the solids for transfer. Some time will be required in the schedule for these transfers.	**Medium Schedule Impact/Risk** Solids will accumulate in the staging tanks in this alternative just like in Alternative 7 but the off-center mixer pump will be less effective in mobilizing the solids. This will require more scheduled time between batches.
Environmental Impact	ND	ND	ND	ND	ND	ND
Regulatory Compliance	ND	ND	ND	ND	ND	ND
Public Acceptance	ND	ND	ND	ND	ND	ND

ND - This is a non-discriminating factor between the alternatives.

[a] Alternatives 1 and 2 were removed from consideration because they did not meet functional requirements.

[b] For Alternatives 5, 6, 7, and 8 the cost includes an additional $1,000,000 incurred by the DST Waste Retrieval System due to the "Control Solids Entrainment at Source Tank" requirement. This assumes that the DST Waste Retrieval System installs a single mixer pump in the central pit of each source tank and that for each of the approximately tanks which require solids entrainment control, a 42 inch 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.

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 slurries.

- Settleable, insoluble solids released 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 Waste 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 8 $3.0 million more expensive than Alternative 4. This assumption makes Alternative 7 $4.3 million more expensive than Alternative 3, and Alternative 8 $5.1 million more expensive than Alternative 4. Without this assumption, Alternative 7 is $0.8 million cheaper than Alternative 3 and Alternatives 4 and 8 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 I 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 Pump Versus Pulsed-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 this 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/risk, 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

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 Mission 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 AGA 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 Indirect 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 use 241-AP-102 and 241-AP-104 as the staging tanks is documented in Decision Document for Phase I Privatization Transfer System Needs (Galbraith 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 criteria 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 # 1 3 2, TWRS Function # 4 2 2)* and the Tank Waste System *(TWRS Architecture # 1 1, TWRS Function # 4 2 1)* 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)

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

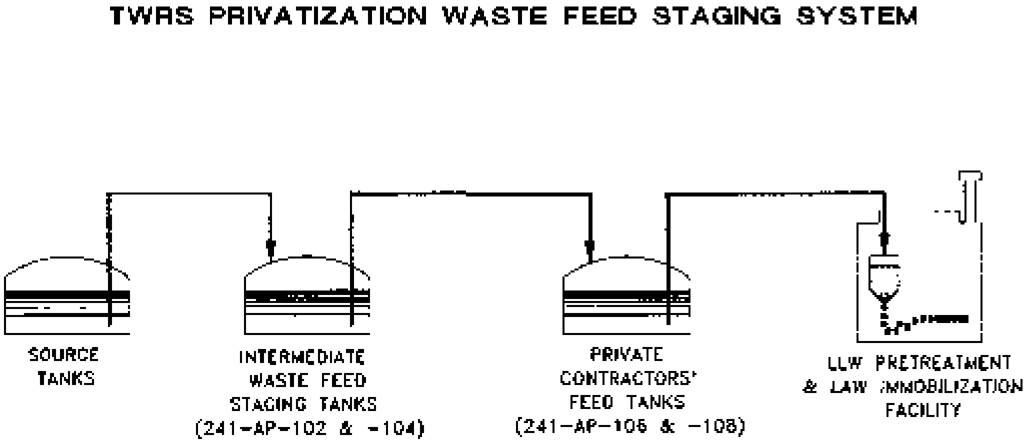


Figure 2-1. Tank Waste Remediation System Phase I Privatization Waste Feed Staging System.

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.

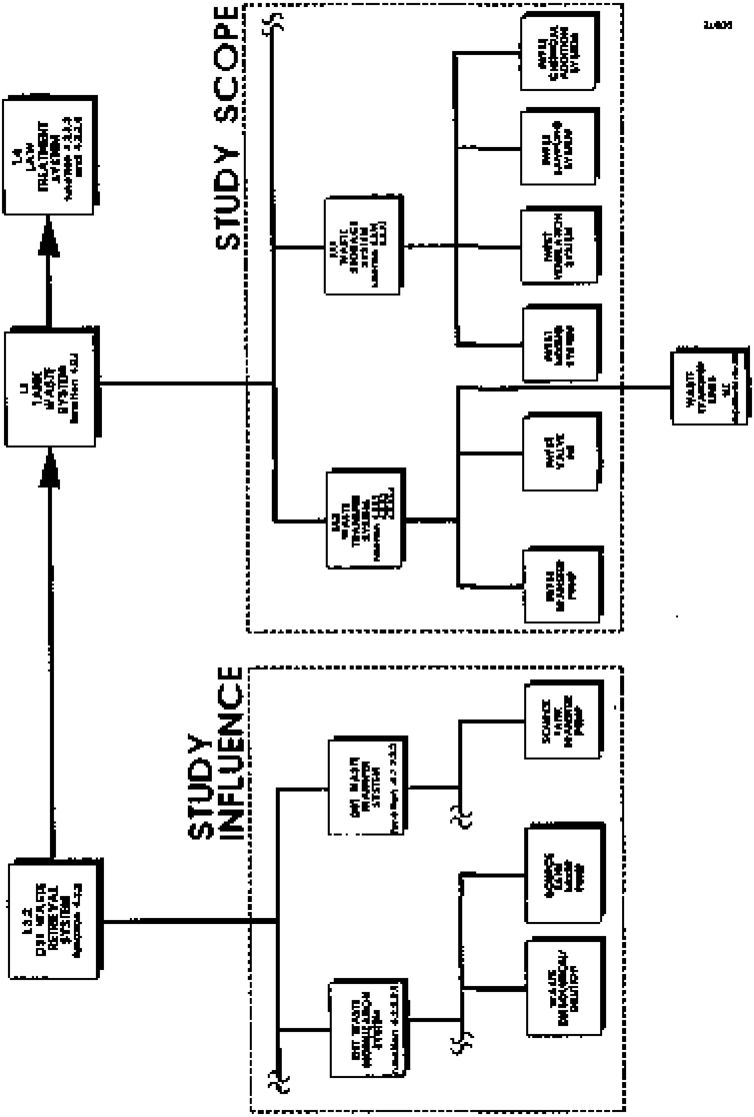
2.2.1 Double-Shell Tank Waste Mobilization System

Some of the waste identified in the *LLW Feed Staging 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 Retrieval System may be required to mix the sludge before the supernatant in some tanks can be retrieved. 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 Flammable 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 soluble 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-Shell 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* (Galbraith et al 1996)

It may be desirable to locate the intake for some of the transfer 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 entrainment) 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 settleable 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 pipelines 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* (Galbraith 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

To verify that the waste feed batches within the staging tank comply with the feed envelope criteria, 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 where in the staging tank should it be located Factors affecting the mixing issue include the benefits in mixing potentially stratified liquid layers (i e , 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, *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 1995)
- WHC-SD-GN-DGS-30011, *Radiological Design Guide* (WHC 1994)
- WHC-SD-TP-SARP-001, *Sample Pig Transport System Safety Analysis Report for Packaging (Onsite)* (Carlstrom 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*

3.1.2 Intermediate Waste Feed Staging System Requirements

Any long-length equipment 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 must be below the limits of the trailers for the handling 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* (McCormick 1996)

- WHC-S-0402, *Specification for Contaminated Equipment Burial Container* (McCormick 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 1996e), 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.c.4. This is taken to mean not only minimizing the use of sodium bearing liquids, 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 IWFSS 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-151-00007 (WHC 1996b).

- *Temperature - Non-Aging Waste DST Waste.* The IWFSS 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 Ventilation System - Pressure.* The IWFSS shall not over- or under-pressurize the tanks based on the limits 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 IWFSS.

- 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.

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

Envelope	A	B	C
Tank	241-AN-103[a] 241-AN-104 241-AN-105 241-AP-104[a] 241-AP-106 241-AW-101	241-AY-101[c]	241-AN-102 241-AN-106[b] 241-AN-107 241-AP-107[b]

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

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

[c] 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 setup 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 Waste 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 supernatants 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 entrained 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.

- 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 fall 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 decant/transfer pump, either 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 during 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 (241-AN-103, 241-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 I Privatization. The accumulated solids will eventually have to be removed, if not in Phase I, then in Phase II

- 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 Mixing 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 KW (70,000 BTU/h) radiolytic heat generation and a maximum solution temperature of 49 °C (120 °F). 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 salts that either did not dissolve during retrieval and transfer or that precipitated after transfer (e g , gibbsite [$NaAlO_2$])

- 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 82 °C (180 °F), the maximum allowable waste temperature

- Four hours of active mixing per day with a single 300-hp mixer pump in a staging tank can be done before the ventilation system is overloaded

- Insoluble solids entrained in the retrieved supernatants 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 entrain 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 supernatant 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-in) risers on the staging tanks, the current transfer pumps and thermocouple trees will be removed and replaced

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 IWFST 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 hot 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.

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

Chemical analyte	Maximum Ratio, analyte (mole) to sodium (mole) [a]		
	Envelope A	Envelope B	Envelope C
Aluminum	0.19	0.19	0.19
Barium	0.0001	0.0001	0.0001
Calcium	0.04	0.04	0.04
Cadmium	0.004	0.004	0.004
Chloride	0.037	**0.089**	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	0.00008
Sodium	1	1	1
Nickel	0.003	0.003	0.003
Nitrite	0.38	0.38	0.38
Nitrate	0.8	0.8	0.8
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**	**0.02**
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, radionuclide (becquerel) to sodium (mole)		
Transuranics	6.00E+05	6.00E+05	**3.00E+06**
^{137}Cesium	4.30E+09	**6.00E+10**	4.30E+09
^{90}Strontium	5.70E+07	5.70E+07	**8.00E+08**

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

Chemical analyte	Maximum Ratio, analyte (mole) to sodium (mole)[a]		
	Envelope A	Envelope B	Envelope C
^{99}Technetium	7.10E+06	7.10E+06	7.10E+06

[a] Shaded numbers highlight differences between the feed envelopes.

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

At least one of these limits must be satisfied.		
Analyte	Minimum Analyte:Na Ratio	Units
Chloride	0.037	mol/mol
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	Bq/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

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 aqueous 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 feed 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.

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 1
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	C	C	C	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
$AlOH_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$CrOH_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+4}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{238}Pu												
^{239}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{240}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Am	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 3-6 Projected Intermediate Waste Feed Staging Tank (AP-104) Feed Batch Sodium Ratios for Private Contractor 2 0 Percent Entrained, Insoluble Solids.

Component	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	AP-101 + AP-10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	D	C	D	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	Estimated Batch Composition [illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (mol)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+4}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{238}Pu												
^{239}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{240}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Am	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 3-7. Projected Intermediate Waste Feed Staging Tank (AP-102) Feed Batch Sodium Ratios for Private Contractor 1. 2 Percent Entrained, Insoluble Solids.

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	AN-105	[illegible] +AP-[illegible]	AN-104	AW-101	AN-103	[illegible]	AN-107	[illegible]	AN-102	[illegible]	[illegible] +AP-[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	B	C	C	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (in M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{238}Pu												
^{239}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{240}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Pu	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Am	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	C	C	C	C
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SpG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ in M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+4}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{241}Am	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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 height 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:

- 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.

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:

- 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 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. Table 3-10 summarizes the number of samples required for each feed batch validation for Private Contractors 1 and 2 for the two percent entrained insoluble solids case.

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

Batch #	Well-Mixed Scenario		Not-Mixed Scenario	
	Contractor 1	Contractor 2	Contractor 1	Contractor 2
1	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	3	3	9	9
7	19	19	89	89
8	19	19	89	89
9	3	3	10	10
10	3	3	4	4
11	3	3	5	4
12	4	3	15	4
Total	74	70	291	266
Scenario Total	144		557	

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

Batch #	Well-Mixed Scenario		Not-Mixed Scenario	
	Contractor 1	Contractor 2	Contractor 1	Contractor 2
1[a]	3	3	7	7
2[a]	4	5	47	34
3[a]	3	3	7	7
4[a]	3	3	4	4
5[a]	3	3	5	5
6	Failed	Failed	Failed	Failed
7	21	21	102	102
8	21	21	102	102
9	3	3	10	10
10[a]	3	3	4	4
11[a]	3	3	5	4
12[b]	Failed	3	Failed	4
Total[c]	77	74	299	286
Scenario Total[c]	151		585	

[a] No solids data available for these batches

[b] No solids data available for Contractor 2's Batch 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

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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 bench 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 preparation requirements and post-maintenance 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 these 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

Gaseous effluent 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 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

Stakeholder value	Study performance measure
Protect the Columbia River	Assessed by environmental acceptability performance measure
Deal realistically and forcefully with groundwater contamination	Not applicable to this study
Do no harm during cleanup or with new development	Assessed by size and location of facilities
Transport waste safely and be prepared for problems	Not assessed
Use the central plateau wisely for waste management	Not applicable
Clean up areas of high future use value	Not assessed
Capture economic development opportunities locally	Not assessed
Involve the public in future decisions about Hanford	This study will be available to the public
Protect the environment	Assessed in safety and environmental performance measures
Protect public/worker health and safety	Assessed in safety, operability and maintainability performance measure
Establish management practices that ensure accountability, efficiency and allocation of funds to high priority items	Not assessed
Get on with the cleanup to achieve substantive progress in a timely manner	Assessed in terms of capability of alternatives to meet Tri Party Agreement schedule
Use a systems approach that keeps end points in mind as intermediate decisions are made	Systems engineering approach incorporated as part of study methodology
Protect Rights of Native American Indians	Not assessed
Cleanup to the level necessary to enable the future use option to occur	Not assessed
Ensure Compliance	Assessed in terms of Environmental Acceptability performance measure
Enhance technology development	Not applicable, uses existing process
Reduce Cost	Directly assessed by cost data for the alternatives
Improve waste management	Not assessed
Use Mature Technologies	Assessed qualitatively as Development Status performance measure
Enhance public acceptance	Not assessed
Use open and fair processes	Systems engineering methodology is used as basis for study
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 screened. 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 Sampling System by informal brainstorming and documented in meeting minutes (Galbraith 1996).

5.1.1 Waste Dissolution/Dilution 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 supernatants 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 soluble 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.

Dissolve 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 height 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 solids 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 Entrainment 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 Entrainment Control. This option places an interface requirement of controlling the entrained 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 dilution 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 supernatant and settled solids layers A single decant/transfer pump installed in each of the staging tanks would be used to decant the supernatants from the settled solids layer

Source Tank and Staging Tank and Solids Entrainment 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 entrainment 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 Feed Staging Tank Mixing System Options

The primary purpose of the IWFST Mixing System, if needed, is to blend stratified liquid layers into a homogenous mixture Stratified layers in the staging 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 mixers are installed 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 Pulsed-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 vertically mix stratified liquid layers in the tank The pulsed-air method may mix stratified liquids layers but this 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 enough momentum 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

Pulsed-Air Mixer - 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 (Rieck 1995)

Mixer Pump On-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.) riser 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 Mixer 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, multiple-mixer pump tests performed by PNNL for determining mixer pump efficiencies.

5.1.3.4 Other Options. Other options that were discussed include the following.

Modified Slurry 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 slurry distributor with a moveable discharge nozzle. The slurry 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 Agitators. Mechanical agitation is not generally considered feasible for mixing 3,785-m^3 (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

Isolok[1]-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 recirculation 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 salts 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)

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[1] Isolok is a registered trademark of Ben E Haeger, Yorkville, IL

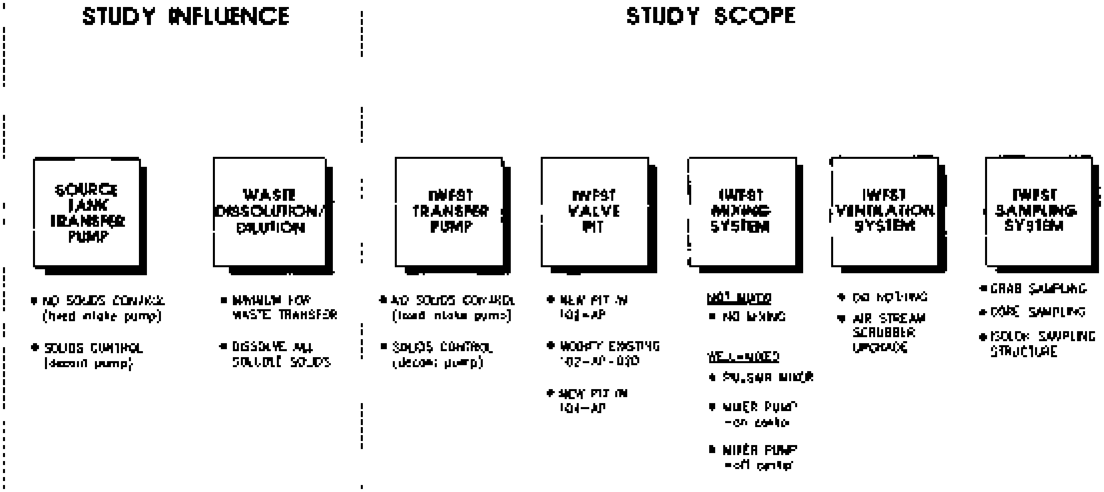

Figure 5-1. Intermediate Waste Feed Staging System Subsystem Options.

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

Alternatives	1[d]	2[d]	3[e]	4	5	6	7	8
Waste Transfer System[a]								
No solids entrainment control[b]								
Solids entrainment control at IWFST	X	X	X	X				
Solids entrainment control at Source Tank					X	X	X	X
Solids entrainment control at IWFST and Source Tank[c]								
IWFST Mixing System								
No Mixer	X				X			
Pulsair Mixer - Single Unit		X				X		
Pulsair Mixer - Multiple Units[c]								
Mixer Pump On-Center			X				X	
Mixer Pump Off-Center				X				X
2 Mixer Pumps Off-Center[b]								
Modified Slurry Distributor[b]								
Mechanical Agitators[b]								

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

[a] Solids entrainment control implies a decant pump at that location and a fixed intake pump at the other location unless otherwise specified.

[b] This option was screened because it did not meet the minimum criteria for this system.

[c] This option was screened because it was more expensive than the other options and provided either no or minimal additional benefits.

[d] If solids entrainment controls are not placed on the retrieval of supernatants into the IWFST, a mixer pump in the IWFST will be required to suspend the settled solids for solids removal. Without solids removal, the solids accumulation would decrease the useable volume of the IWFSTs and the schedule would be missed.

[e] Both the "Solids entrainment control at IWFST" and the "Mixer Pump on-Center" options currently require the exclusive use of the only 106.7-cm (42-in.) riser available on the IWFSTs. Therefore, these options cannot be used together without some redesign of the decant/transfer pump.

ALTERNATIVES	STUDY INFLUENCE		STUDY SCOPE				
	SOURCE TANK TRANSFER PUMP	WASTE DISSOLUTION AND DILUTION	IWFST TRANSFER PUMP	IWFST VALVE PITS	IWFST MIXING SYSTEM	IWFST VENTILATION SYSTEM	IWFST SAMPLING SYSTEM
1	• NO SOLIDS CONTROL (fixed intake pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• SOLIDS CONTROL (decant pump)		• NO MIXER	• DO NOTHING	• GRAB SAMPLING
2	• NO SOLIDS CONTROL (fixed intake pump)	• DISSOLVE ALL SOLUBLE SOLIDS	SOLIDS CONTROL (decant pump)		• PULSED AIR MIXER	• DO NOTHING	• GRAB SAMPLING
3	• NO SOLIDS CONTROL (fixed intake pump)	• MINIMUM FOR WASTE TRANSFER	• SOLIDS CONTROL (decant pump)		• MIXER PUMP -on center	• DO NOTHING	• GRAB SAMPLING
4	• NO SOLIDS CONTROL (fixed intake pump)	• MINIMUM FOR WASTE TRANSFER	• SOLIDS CONTROL (decant pump)		• MIXER PUMP -off center	• DO NOTHING	• GRAB SAMPLING
5	• SOLIDS CONTROL (decant pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• NO SOLIDS CONTROL (fixed intake pump)		• NO MIXER	• DO NOTHING	• GRAB SAMPLING
6	• SOLIDS CONTROL (decant pump)	• DISSOLVE ALL SOLUBLE SOLIDS	• NO SOLIDS CONTROL (fixed intake pump)		• PULSED AIR MIXER	• DO NOTHING	• GRAB SAMPLING
7	• SOLIDS CONTROL (decant pump)	• MINIMUM FOR WASTE TRANSFER	• NO SOLIDS CONTROL (fixed intake pump)		• MIXER PUMP -on center	• DO NOTHING	• GRAB SAMPLING
8	• SOLIDS CONTROL (decant pump)	• MINIMUM FOR WASTE TRANSFER	• NO SOLIDS CONTROL (fixed intake pump)		• MIXER PUMP -off center	• DO NOTHING	• GRAB SAMPLING

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

5.2.1 Alternative 1

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., sludges) 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).*
- Dissolve 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 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.

5.2.3 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 meet waste transfer requirements.

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 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.

IWFSS 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/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).
- 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.

IWFSS Options.

- A fixed-intake transfer pump in each IWFST (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 Staging Plan* (Certa et al 1996) Option 2 looked at using the existing 241-AP 02D Pump Pit 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 Pit 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 Appendix 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 This pit could be used in the future for in-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 entrainment 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 removal 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 immobilization 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 supernate 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-in) riser in the central pump pit This would coincide 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 burnout There would be no difference in cost for this concept if the decant/transfer pump (or a fixed-intake pump) is installed in a 30 5-cm (12-in) riser in the central pump pit Currently a decant/transfer pump that will operate with a mixing system has not been designed that will fit in a 30 5-cm (12-in) riser

The second concept would be to add a new pump pit above the off-center 106 7-cm (42-in) riser This coincides with Option 2 in the Mixing System AOA (see Appendix A) that uses the central pump pit 106 7-cm (42-in) riser for the mixer 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 includes 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 decon 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-in 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) riser 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 pit 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 costs.

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 previous 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-Air 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 compressor. 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 stainless steel pipe, with a Double Accumulator Plate (DAP) welded to the end. A DAP is made up of two stainless steel plates (size of plate is dependant of riser diameter). 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.

Concept	Cost ($ million)	Alternative							
		1[a]	2[a]	3	4	5	6	7	8
SN-650 Transfer System									
Option 1 or Option 3	2.8	✓	✓	✓	✓	✓	✓	✓	✓
Option 2	1.9	Screened Concept							
No Mixing System									
No Mixer with Decant Pump (106.7 cm [42 in.])	8.3	✓							
No Mixer with Fixed-Intake Pump (30.5 cm [12 in.])	8.3					✓			
Pulsair Mixing System and Decant/Transfer Pump									
Pulsair Mixing with Decant Pump (106.7 cm [42 in.])	12.4[b]		✓						
Pulsair Mixing with Mixed-Intake Pump (30.5 cm [12 in.])	11.6[c]						✓		
Mixing System and Decant/Transfer Pump									
On-Center Mixing with Decant Pump (106.7 cm [42 in.])	18.6			✓					
Off-Center Mixing with Decant Pump (106.7 cm [42 in.])	16.6				✓				
On-Center Mixing with Fixed-Intake Pump (30.5 cm [12 in.])	17.8							✓	
Off-Center Mixing with Fixed-Intake Pump (30.5 cm [12 in.])	16.6								✓
Total Construction Cost ($ million)		11.1	15.2	21.4	19.4	11.1	14.4 (14.0)[d]	20.6 (20.2)[d]	19.4

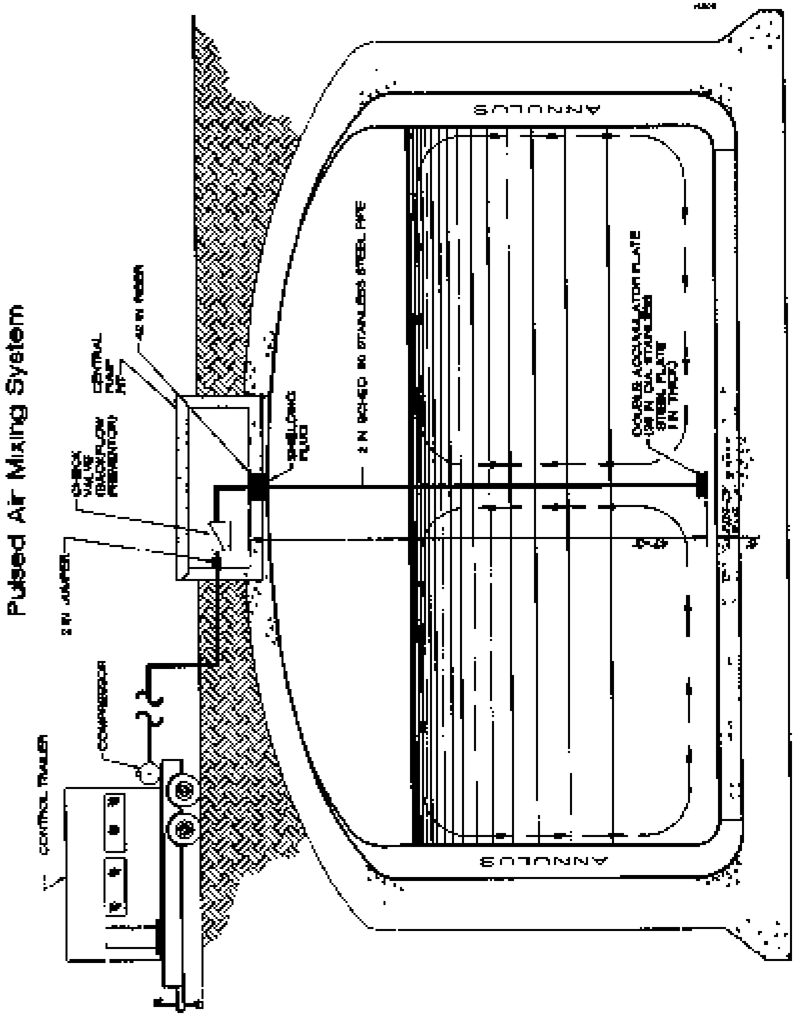
[a] Screened Alternatives.

[b] The cost includes an additional $1.7 million for new pits on Tanks 241-AP-102 and -104.

[c] The cost includes an additional $0.9 million for a new pit on Tank 241-AP-104.

[d] The total cost is reduced approximately $0.4 million to account for shared pit costs between the fixed-intake pump pit on Tank 241-AP-104 and the new process pit in the Transfer System Option 3.

Figure 6-1. Pulsed-Air Mixing System.



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 buoyant 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 waste (Figure 6-1)

Installation of the pulsed-air mixing system will be as follows A shielding plug will be fabricated on the top end of the ADA, which will then be lowered into the riser, as one rigid 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 ft^3 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 riser 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-m^3 (1 Mgal) 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-entrainment devices were investigated The evaluation concluded that fluidics 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 mixing system Fluidics devices have no mechanical parts, and therefore are very low maintenance The ventilation evaluation (Appendix E) concluded that upgrade of the ventilation system was not warranted based on a life-cycle cost comparison 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 shuts down, the pulsed-air mixer will automatically shut down. Another (potential) safety advantage is that 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 pumps (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 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.

6.2.4 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 system 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 Farm. The facility uses an Isolok®-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 hardware 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.

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

Cost component	Alternatives[a]					
	3	4	5	6	7	8
DST WASTE RETRIEVAL SYSTEM REQUIREMENTS						
Solids entrainment control Requirement	No Solids Control	No Solids Control	Control Solids	Control Solids	Control Solids	Control Solids
Dissolution/Dilution Requirement	Maximum For Waste Transfer	Minimum For Waste Transfer	Dissolve Before Waste Transfer	Dissolve Before Waste Transfer	Minimum For Waste Transfer	Maximum For Waste Transfer
Pump Pit Capital (TECC)	$0	$0	$5,100,000	$5,100,000	$5,100,000	$5,100,000
IWFST WASTE TRANSFER AND MIXING SYSTEMS						
Transfer Pump Option	Decant Pump (42-in riser)	Decant Pump (42-in Riser)	Fixed-Intake Pump	Fixed-Intake Pump	Fixed-Intake Pump	Fixed-Intake Pump
Mixing System Option	Mixer Pump On-Center	Mixer Pump Off-Center	No Mixer	Pulsed Air Mixer	Mixer Pump On-Center	Mixer Pump Off-Center
Transfer Pump/Mixer Capital (TECC)	$18,600,000	$16,600,000	$8,300,000	$11,600,000	$17,800,000	$16,600,000
Valve Pit Capital (TECC)	$2,800,000	$2,800,000	$2,800,000	$2,800,000	$2,800,000	$2,800,000
Total Transfer & Mixing System Capital	$21,400,000	$19,400,000	$11,100,000	$14,400,000	$20,600,000	$19,400,000
IWFST CHEMICAL ADDITION SYSTEM						
Capital (TECC)	$1,600,000	$1,600,000	$1,600,000	$1,600,000	$1,600,000	$1,600,000
IWFST VENTILATION SYSTEM						
Option	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
IWFST SAMPLING SYSTEM						
Option	Grab	Grab	Grab	Grab	Grab	Grab
Capital	$0	$0	$0	$0	$0	$0
		$1,320,000 $530,000 $320,000 $60,000	$1,320,000 $1,380,000 $1,850,000 $180,000	$1,320,000 $530,000 $320,000 $60,000	$1,320,000 $530,000 $320,000 $60,000	Operating[b] - Sampling Prep - Sampling - Exposure Detriment - Transportation

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

Cost component	Alternatives[a]					
	3	4	5	6	7	8
Analysis[b] • Liquid Analysis • Solids Analysis • Core Handling	 $670,000 $760,000 N/A	 $670,000 $760,000 N/A	 $2,400,000 $2,710,000 N/A	 $670,000 $760,000 N/A	 $670,000 $760,000 N/A	 $670,000 $760,000 N/A
Sampling System Total	$3,860,000	$3,860,000	$9,840,000	$3,860,000	$3,860,000	$3,860,000
ALTERNATIVE TOTALS						
Capital (TECC)[c]	$23,000,000	$21,000,000	$17,800,000	$21,100,000	$27,300,000	$26,100,000
Operating	$3,860,000	$3,860,000	$9,840,000	$3,860,000	$3,860,000	$3,860,000
Total[c, d]	$26,860,000	$24,860,000	$27,650,000	$24,960,000	$31,160,000	$29,960,000

[a] Alternatives 1 and 2 were screened from consideration.

[b] Sample cost is based on feed batches with 2 percent entrained insoluble solids.

[c] This cost includes an additional $4,100,000 incurred by the DST Waste 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.

[d] The total cost does not include costs for replacement of failed equipment (i.e., mixer and transfer pumps). The current design life for the new equipment (i.e., mixer 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.

Alternative 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, 241-AP-102 Grout Feed Tank and 241-SY-101 Tank Mitigation. The Grout 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 from 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.

Alternatives 6. With regard to maintainability, Alternative 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 this criterion.

Alternative 5. Alternative 5 does not employ an active mixing 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/transfer pumps in these alternatives allow the IWFSS to decant supernatants 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 on-center 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 or transfer.

Alternatives 5 and 6. Alternatives 5 and 6 are ranked lowest in being able to respond to off-normal 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 soluble 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 entrainment 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 schedules 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 tank 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 removal of the insoluble ones.

7.7 ENVIRONMENTAL IMPACT

All the alternatives are judged to equal in this criterion.

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

- **Impact 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 related 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

- **Control 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 supernatant 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 transfer 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 stipulated 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 highest possible sodium quantity in the feed batch (nominal mass plus the uncertainty)

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.

9.0 REFERENCES

ASME B31.3, 1996 Edition, *Process Piping*, American Society of Mechanical Engineers.

Carlstrom, R. F., 1995, *Sample Pig Transport System Safety Analysis Report for Packaging (Onsite)*, WHC-SD-TP-SARP-001, Rev. 0G, Westinghouse Hanford Company, Richland, Washington.

Carpenter, K. E., 1996, *TWRS Functions and Requirements (F&R) Document*, WHC-SD-WM-FRD-020, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Certa, P. J., W. H. Grams, C. M. McConville, L. W. Shelton, and E. J. Slaathaug, 1996, *Low-Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-224, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *General Design Criteria*, DOE Order 6430.1A, U.S. Department of Energy, Washington, D.C.

DOE, 1993, *Natural Phenomena Hazards Mitigation*, DOE Order 5480.28, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1996, *TWRS Privatization Request for Proposals*, Solicitation Number DE-RP06-96RL13308 (February 1996), U.S. Department of Energy - Richland Operations Office, Richland Washington.

Fowler, K. D., 1995, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, WHC-SD-WM-DQO-001, Rev. 1, Westinghouse Hanford Company, Richland Washington.

Galbraith, J. D., 1996, *Alternative Generation Session for Upgrades of AP-102 and 104*, (meeting minutes, June 13), Westinghouse Hanford Company, Richland, Washington.

Galbraith, J. D., T. B. Salzano (ICF KH), and J. R. Nicholson (ICF KH), 1996, *Decision Document for Phase I Privatization Transfer System Needs*, WHC-SD-WM-TI-750, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

McCormick, W. A., 1996, *Specification for Trailers for the Handling and Transport of Tank Farms Long Length Contaminated Equipment*, WHC-S-0321, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

McCormick, W A and W S Edwards, 1996, *Specification for Contaminated Equipment Burial Container*, WHC-S-0402, Rev 0B, Westinghouse Hanford Company, Richland, Washington

Milliken, N J, 1995, *Safety Analysis for Push-Mode and Rotary-Mode Core Sampling*, WHC-SD-WM-SARR-031, Rev 2, Westinghouse Hanford Company, Richland, Washington

Powell, M R and C R Hymas, 1996, *Retrieval Process Development and Enhancements FY96 Pulsed-Air Mixer Testing and Deployment Study*, PNNL-11200, Pacific Northwest National Laboratories, Richland Washington

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

Simpson, B C, 1994a, *Tank Characterization Report for Double Shell Tank 241-AP-105*, WHC-SD-WM-ER-358, Rev 0, Westinghouse Hanford Company, Richland Washington

Simpson, B C, 1994b, *Tank Characterization Report for Double Shell Tank 241-AP-102*, WHC-SD-WM-ER-360, Rev 0, Westinghouse Hanford Company, Richland Washington

WAC 173-303-640, "Dangerous Waste Regulations, Tank Systems," *Washington Administrative Code*, as amended

Welsh, T L, 1994a, *Tank 241-AP-102 Characterization and Grout Product Test Results*, WHC-SD-WM-TRP-168, Rev 1, Westinghouse Hanford Company, Richland Washington

Welsh, T L, 1994b, *Tank 241-AP-105 Characterization Results*, WHC-SD-WM-TRP-169, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1992a, *Hazardous Material Packaging and Shipping*, WHC-CM-2-14, Westinghouse Hanford Company, Richland, Washington

WHC, 1992b, *Safety Classification of Structures, Systems, and Components*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington

WHC, 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1995, *WHC Occupational ALARA Program*, WHC-IP-1043, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1996a, *Double-Shell Tanks Interim Operational Safety Requirements*, WHC-SD-WM-OSR-016, Rev. 0B, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996b, *Operating Specifications for the 241-AN, AP, AW, AY, AZ, and SY Tank Farms*, OSD-T-151-00007, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996c, *TWRS Functions and Requirements (F&R) Document*, WHC-SD-WM-PRD-020, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996d, *Tank Waste Remediation System Mission Analysis*, WHC-SD-WM-MAR-008, WHC-SD-WM-TRP-168, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996e, *Decision Document, Low-level Waste Feed Staging Strategy*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

MIXING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

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APPENDIX A

MIXING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

A1.0 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 (IWFST) 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 IWFSTs to support the staging of low-activity waste (LAW) for Phase I privatization?

A1.2 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 exceeded 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 decant pump could be installed in a 30.5-cm (12-in.) riser. This would reduce the upgrades needed to the IWFSTs.

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 IWFSTs 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 pumps were selected for Project W-211 (Rieck 1996) as the appropriate technology to remove settled solids and are, therefore, selected for the IWFSTs.

A1.3.1 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 were identified (Waters 1994) as follows:

- 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.) riser 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 slurry 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 riser 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 failed mixer pump in tank 241-AP-102 and the slurry distributor in tank 241-AP-104. The location of the 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.) riser 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 IWFSTs. 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 stainless 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 a 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 required on the central pump pits to support the installation of the new mixer pumps. The location of the mixer pumps on the IWFSTs 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 Figure 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.

Figure A1-1. Mixer Pump on Slab: 241-AP-102.

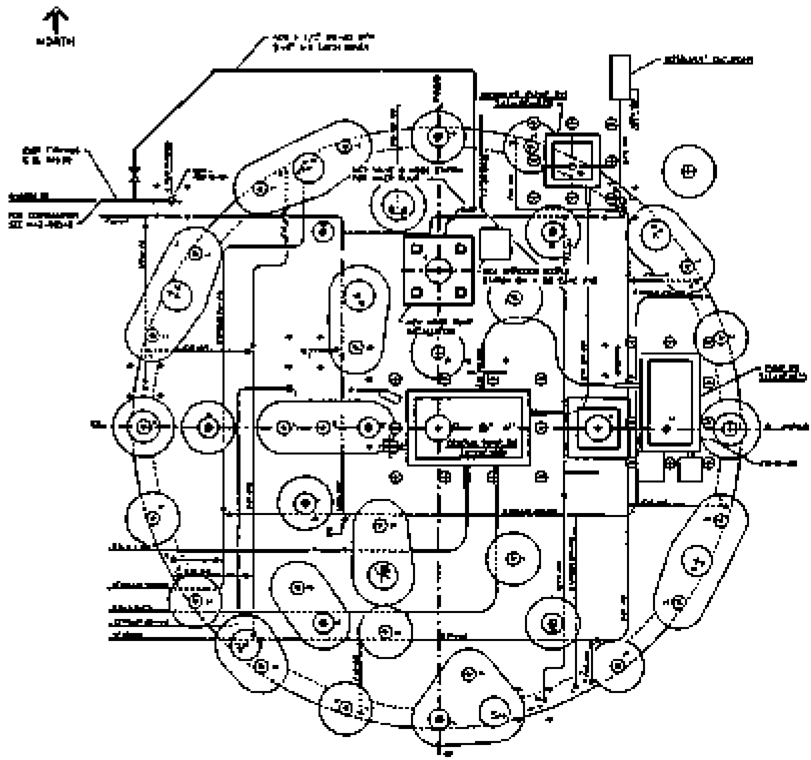

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Figure A1-2 Mixer Pump on Slab 241-AP-104

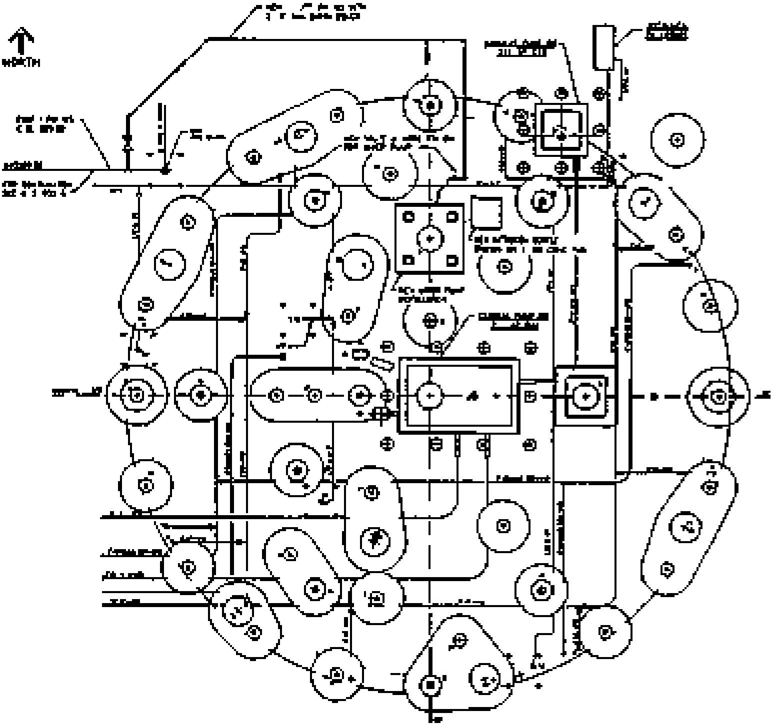

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Figure A1-3. Mixer Pump on Slab: Assembly.

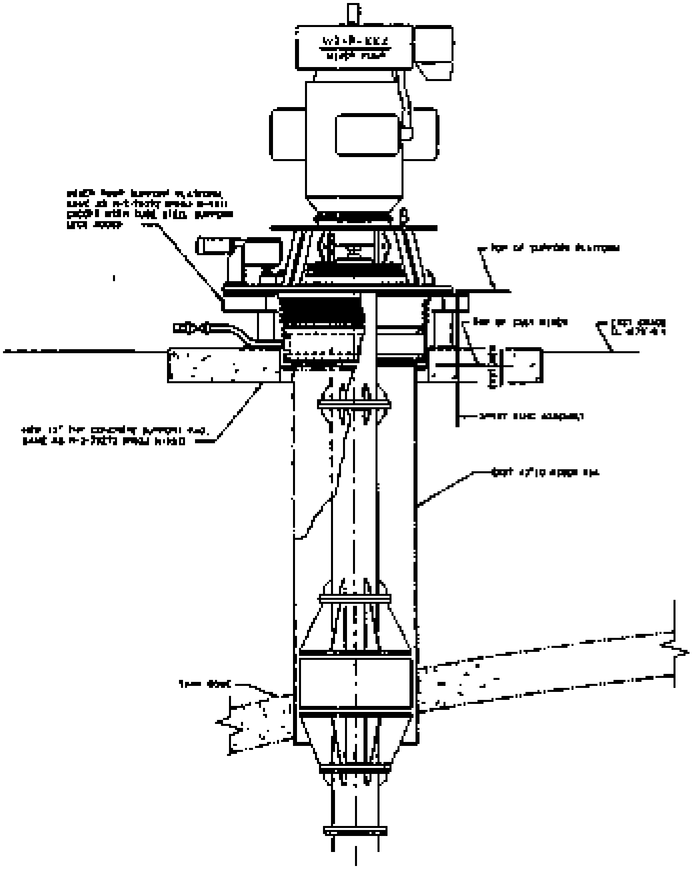

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Figure A1-4. Mixer Pump above Central Pump Pit: 241-AP-102.

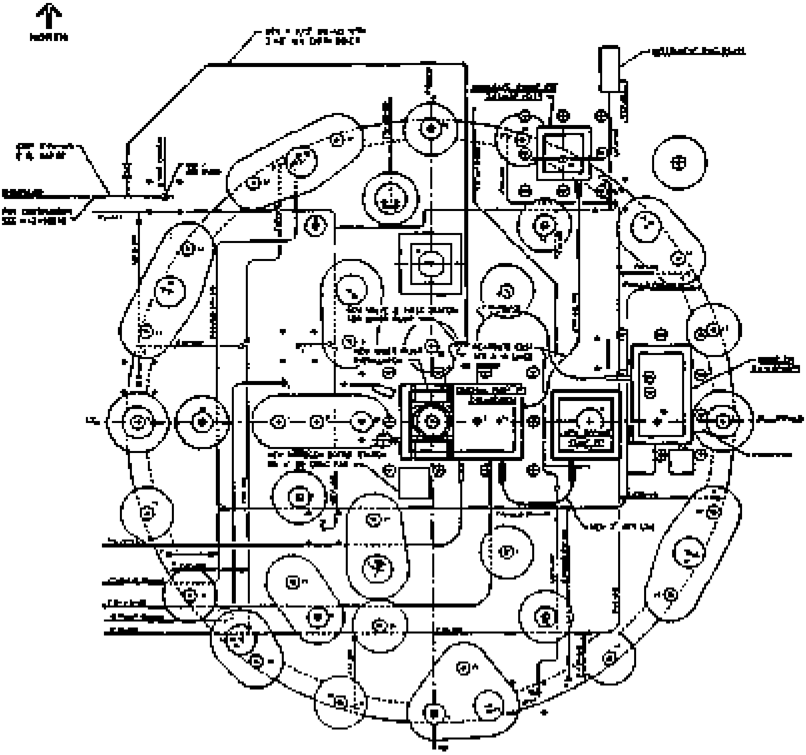

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Figure A1-5. Mixer Pump above Central Pump Pit: 241-AP-104.

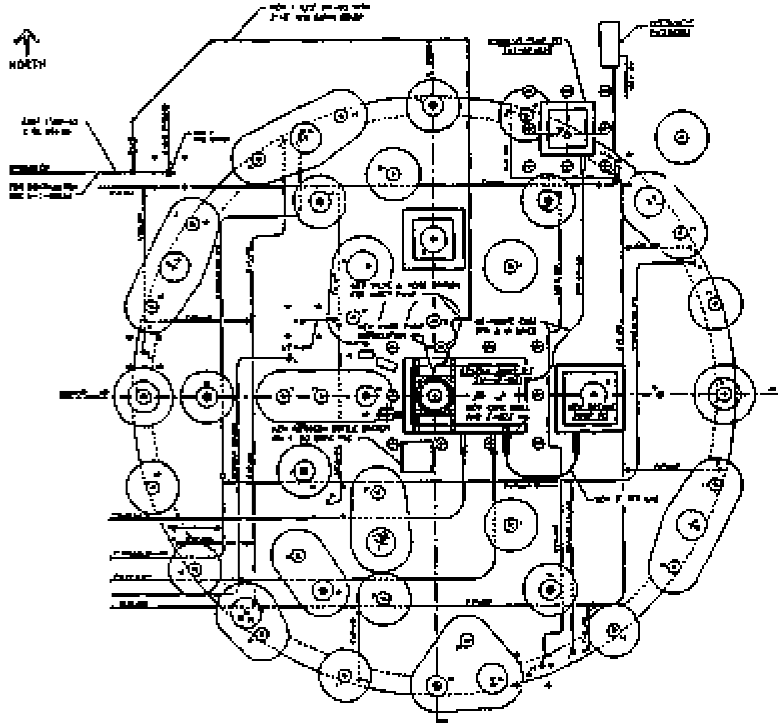

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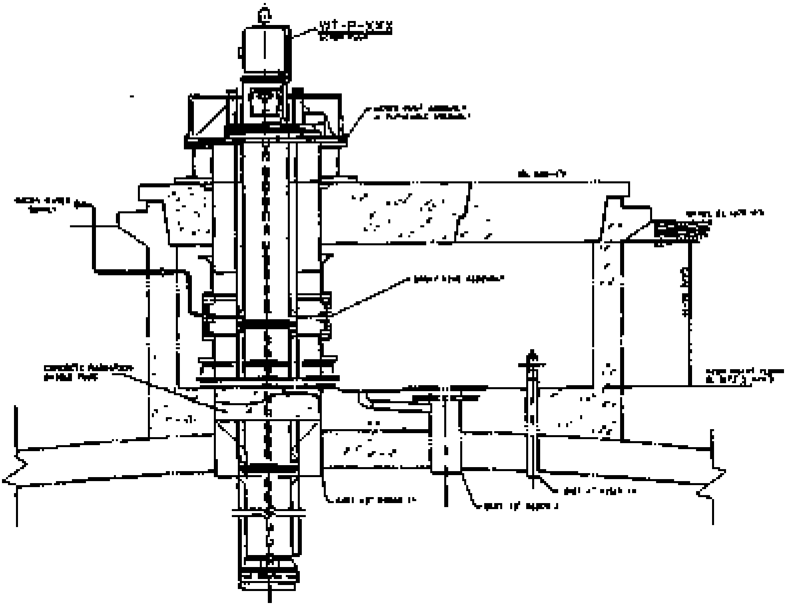
Figure A1-6. Mixer Pump above Central Pump Pit: Assembly.



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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 dissolve 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, $NaNO_2$, $NaNO_3$, and H_2O
- 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 LWFSTs 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 satisfactorily 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.

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

Decision Criteria	Option	
	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 items. 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.
Maintainability	The systems associated with Option 1 are all common to the Hanford Site and no additional training is required of personnel. 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 1

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

Decision Criteria	Option	
	Option 1 "Mixer Pump on Slab"	Option 2 "Mixer Pump above Central Pump Pit"
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.

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 necessary 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 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, *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 burial 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 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*
- 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.
- Decant 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 (Galbraith 1996b). The options generated for the mixing system consist of the following: Mixer pump system, pulsed air mixing system, and a modified slurry 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 criteria of technical maturity. The pulsed 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 slurry distributor system would need to be tested and evaluated in scaled models before it would be feasible in the IWFSTs. Therefore, the modified slurry 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 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. 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 IWFST. 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 run-in test and shop modifications is approximately $510,000. If the winch mechanism is not required, the cost would be approximately $450,000.

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 IWFSTs are approximately $120,000.

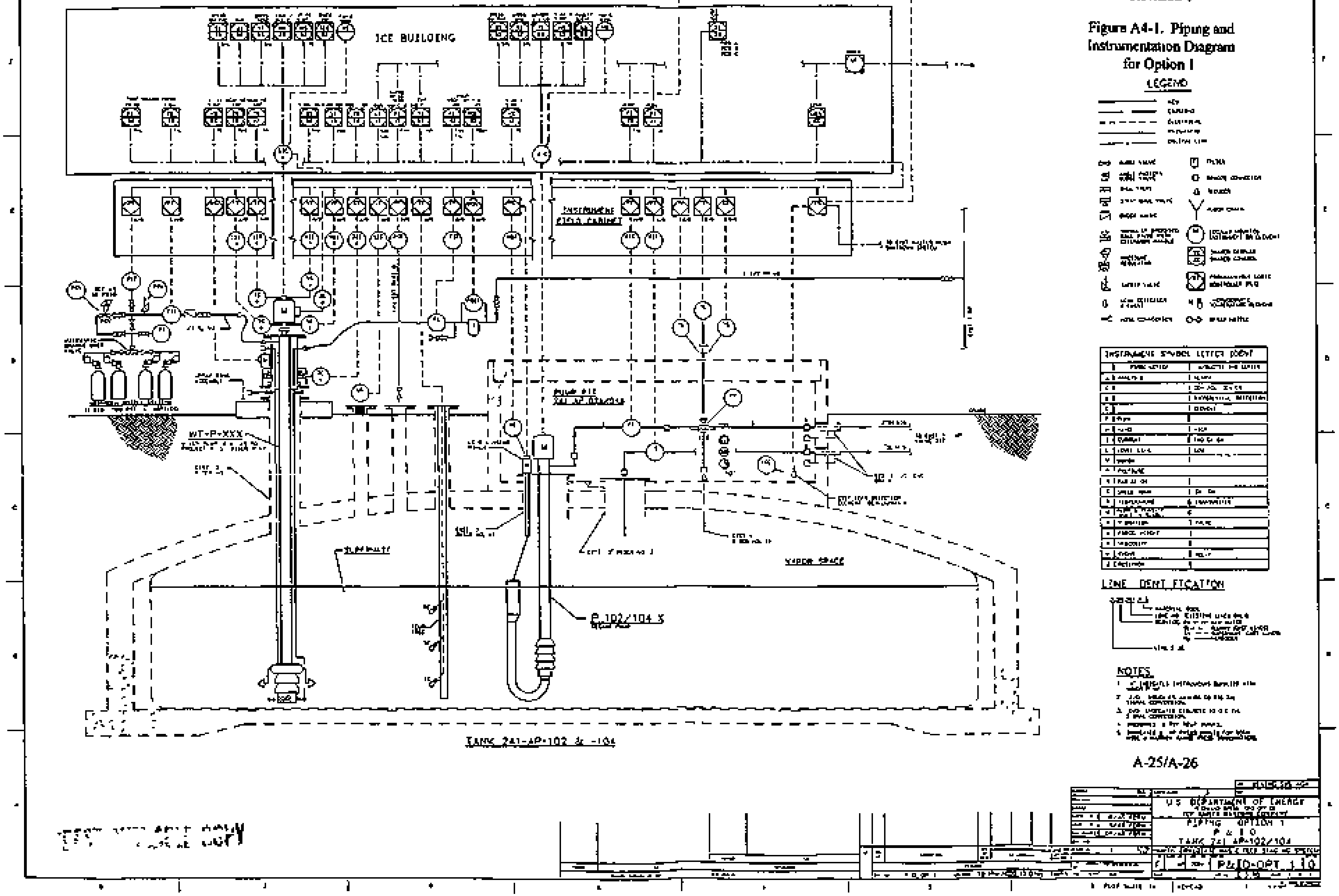
The failed mixing pump and the slurry distributor for tank 241-AP-102 in the central pump pit need to be removed. In addition, the existing transfer pumps and thermocouple trees need to be removed. The cost for removal and disposal of this equipment is approximately $5,500,000. This includes $2,900,000 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 in.]), 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 1 is shown in Figure A4-1.

Figure A4-1. Piping and Instrumentation Diagram for Option 1



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

- Purchase of one ADMP and one supernate decant/transfer pump.
- 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.
- Fabricate 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 pump.
- Modify the central pump pit jumper arrangement as shown in Figure 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:

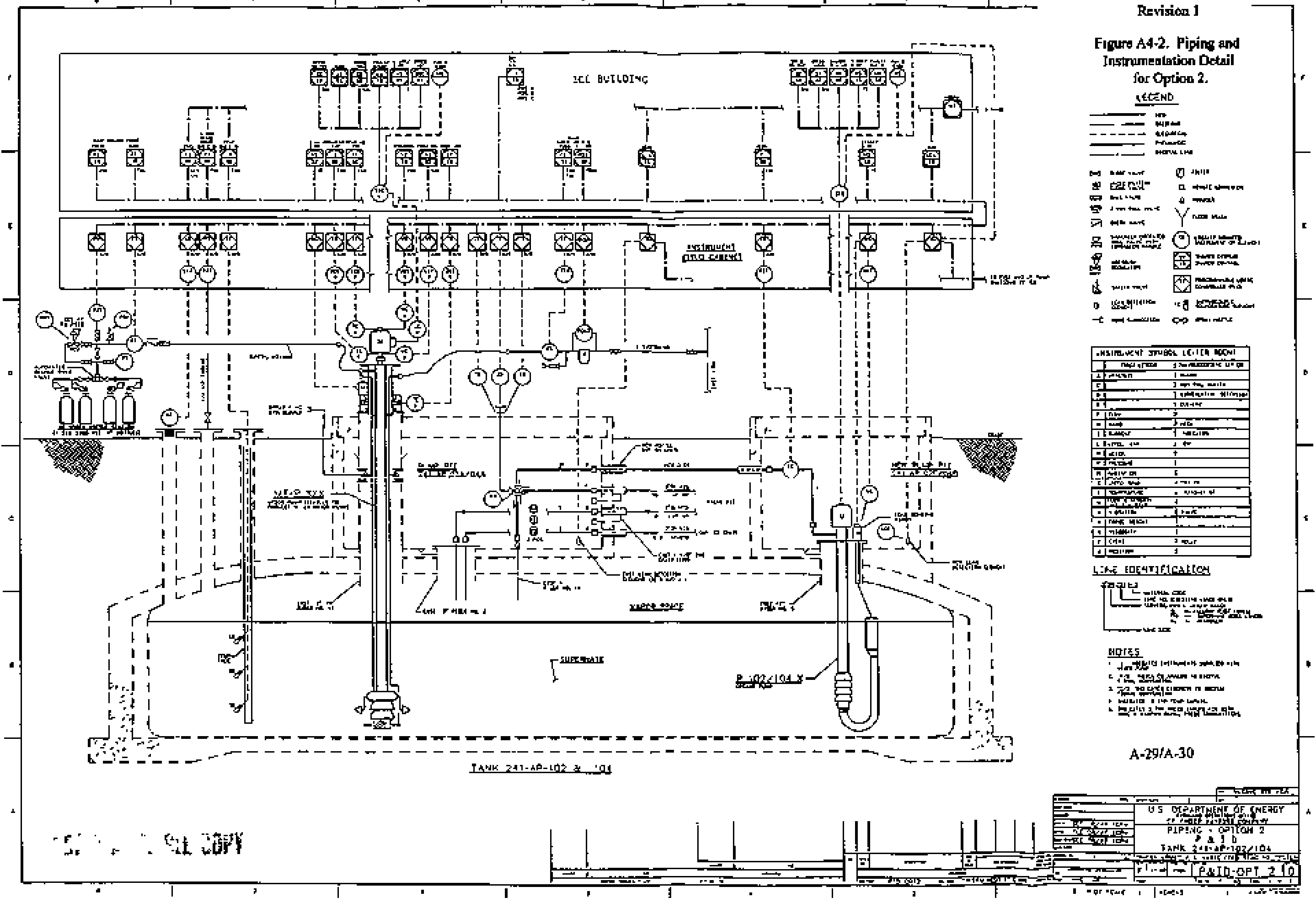
- Purchase of one ADMP and one supernate decant/transfer pump.
- Install approximately 29 m (95 ft) of new (3.8-cm [1.5-in.]) raw water line including a new valve and hose station.
- Install the mixer pump on the cover blocks of the central pump pit. This will require the replacement of the existing 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 stainless 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 (21 ft) 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.

Figure A4-2. Piping and Instrumentation Detail for Option 2.



A5.0 REFERENCES

Carpenter, K. E., 1996, *TWRS Functions and Requirements Document*, WHC-SD-WM-FRD-020, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Certa, P. J., 1996, *Low-Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-224, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *General Design Criteria*, DOE Order 6430.1A, U.S. Department of Energy, Washington, D.C.

DOE, 1993, *Natural Phenomena Hazards Mitigation*, DOE Order 5480.28, U.S. Department of Energy, Washington, D.C.

DOE, 1995, *TWRS Privatization Requests for Proposals - Draft*, Solicitation Number DE-RP06-96RL13308, U.S. Department of Energy, Richland Operations, Richland, Washington.

Galbraith, J. D., T. B. Salzano, and J. R. Nicholson, 1996a, *Decision Document for Phase I Privatization Transfer System Needs*, WHC-SD-WM-TI-750, Rev. 0, Draft, Westinghouse Hanford Company, Richland, Washington.

Galbraith, J. D., 1996b, *Alternative Generation Session for Upgrades of AP-102 and 104*, Meeting Minutes, dated June 13, 1996, Westinghouse Hanford Company, Richland, Washington.

Lawler, J. H., 1984, *Grout Feed Tank Mixer Working Papers*, SD-RE-TI-127, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

Lawler, J. H., 1986a, *Double-Shell Tank Waste Retrieval Technology Program Plan*, SD-WM-TPP-009, Rev. 1, Rockwell Hanford Operations, Richland, Washington.

Lawler, J. H., 1986b, *Neutralized Current Acid Waste (NCAW) Retrieval Methods*, SD-WM-TI-231, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

McCormick, W. A., 1996, *Specification for Trailers for the Handling and Transport of Tank Farms Long-Length Contaminated Equipment*, WHC-S-0321, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

McCormick, W. A., and W. S. Edwards, 1996, *Specification for Contaminated Equipment Burial Container*, WHC-S-0402, Rev. 0B, Westinghouse Hanford Company, Richland, Washington.

Rieck, C. A., 1995, *Title I Design Summary Report, Initial Tank Retrieval Systems, Project W-211*, WHC-SD-W211-TDR-001, Rev. 0B (Supplement 2), Westinghouse Hanford Company, Richland, Washington.

Rieck, C. A., 1996, *Functional Design Criteria, Project W-211, Initial Tank Retrieval Systems*, WHC-SD-W211-FDC-001, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

RHO, 1984, *Hanford Waste Management Plan*, RHO-WM-PL-9, Rev. 2, Rockwell Hanford Operations, Richland, Washington.

Shaw, C. P., 1992, *Mixer Pump Study for Project W151*, WHC-SD-WM-ES-195, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WAC 173-303-640, 1990, "Dangerous Waste Regulations, Tank Systems," *Washington Administrative Code*, as amended.

Waters, E. D., 1994, *Background and Status of Hanford's DST Retrieval Technology*, WHC-SD-WM-TI-593, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992a, *Safety Classification of Structures, Systems, and Components*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992b, *BNFL Developed Mixing Technologies to Support the WHC Organics Tank Program*, TRAC-0748, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *WHC Occupational ALARA Program*, WHC-IP-1043, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996a, *Operating Specifications for the 241-AN, AP, AW, AY, AZ & SY Tank Farms*, OSD-T-151-00007, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996b, *Double-Shell Tanks Interim Operational Safety Requirements*, WHC-SD-WM-OSR-016, Rev. 0B, Westinghouse Hanford Company, Richland, Washington.

A6.0 COST ESTIMATES

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ICF KAISER HANFORD                               ** ICES   INTERACTIVE ESTIMATING **                  PAGE   1  OF   8
WESTINGHOUSE HANFORD COMPANY           AP 102/104 PULSE AIR MIXER (THRU 12" RISER)                   DATE   08/28/96 AT 08 24
JOB NO  24105A03                                          STUDY                                      BY     J P H
FILE NO  24105A03                             DOE_001   PROJECT COST SUMMARY


            COST                                                  ESCALATED       CONTINGENCY          TOTAL
            CODE     DESCRIPTION                                  TOTAL COST     %        TOTAL       DOLLARS
            -----    ----------------------------------------    -----------   -----  -----------  -----------

            020      TITLE II DESIGN                                 145,000      25       36,000      181,000
            030      TITLE III DESIGN                                 62,000      25       16,000       78,000
            040      PROJECT MANAGEMENT                               69,000      25       17,000       86,000
                      (ADJUSTED TO MEET DOE 5100 4)                    4,000                1,000        5,000
                                                                 -----------------------------------------------
            TOTAL DESIGN AND MANAGEMENT                              280,000      25       70,000      350,000


            700      SPECIAL EQUIP/PROCESS SYSTEMS                   701,000      29      205,000      906,000
                      (ADJUSTED TO MEET DOE 5100 4)                   -1,000                5,000        4,000
                                                                 -----------------------------------------------
                                                                     700,000      30      210,000      910,000

            TOTAL ESTIMATED CONSTRUCTION COSTS  (TEC)                980,000              280 000    1,260,000


            900      OTHER PROJECT COSTS                              57,000      25       14,000       71,000
                      (ADJUSTED TO MEET DOE 5100 4)                    3,000               -4,000       -1,000
                                                                 -----------------------------------------------
            TOTAL OTHER PROJECT COSTS  (OPC)                          60,000      16       10,000       70,000

                                                                 -----------------------------------------------

            TOTAL PROJECT COST   (TPC)                             1,040,000      28      290,000    1,330,000


   TYPE OF                                                     REMARKS
   ESTIMATE      STUDY ESTIMATE      AUGUST 28  1996

   ARCHITECT                                                   PROJECT SCHEDULE WAS NOT PROVIDED   THEREFORE NO
   ENGINEER                                                    ESCALATION PERCENTAGES HAVE BEEN APPLIED

   OPERATING
   CONTRACTOR

            (ROUNDED/ADJUSTED TO THE NEAREST '  1 000 /  10 000 '   PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)
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CHECK

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ICF KAISER HANFORD                            ** TEST - INTERACTIVE ESTIMATING **                        PAGE  2  OF  2
WESTINGHOUSE HANFORD COMPANY               AP-102/104 PULSE AIR SYSTEM (THRU 12" RISERS)                 DATE  08/26/96 07:02:37
JOB NO. 24143AD5                                            STUDY                                        BY    J P K
FILE NO. Z416BAD3                              DOC_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

                                                ESTIMATE    ONSITE       SUB       ESCALATION        SUB      CONTINGENCY      TOTAL
 WBS    DESCRIPTION                             SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL      TOTAL     %     TOTAL     DOLLARS
------ ---------------------------------       --------   ---------  ---------  ------ --------  --------- ----- ---------  ---------

111100 DEFINITIVE DESIGN-OFFSITE A/E             145000          0     145000    0.00        0     145000   25      36250     181250
121000 ENGINEERING/INSPECTION-ONSITE E/C          62000          0      62000    0.00        0      62000   25      15500      77500

  SUBTOTAL 1      ENGINEERING                    207000          0     207000    0.00        0     207000   25      51750     258750

310100 AP 102/104 12" RISER                      265489          0     265489    0.00        0     265489   28      74544     340033
310200 AP 102/104 PULSE AIR SYSTEM               426112          0     426112    0.00        0     426112   30     127833     553945

  SUBTOTAL 31     FA CONST-ONSITE E/C            691601          0     691601    0.00        0     691601   29     202377     893978

330000 BURIAL FEE-O/C                              9519          0       9519    0.00        0       9519   30       2856      12375

  SUBTOTAL 33     BURIAL FEE-O/C                   9519          0       9519    0.00        0       9519   30       2856      12375

  SUBTOTAL 3      CONSTRUCTION                   701120          0     701120    0.00        0     701120   29     205233     906353

400000 PROJECT MANAGEMENT                         69000          0      69000    0.00        0      69000   25      17250      86250

  SUBTOTAL 4      PROJECT INTEGRATION             69000          0      69000    0.00        0      69000   25      17250      86250

500000 OTHER PROJECT COST                         57402          0      57402    0.00        0      57402   25      14351      71753

  SUBTOTAL 5      OTHER PROJECT COST              57402          0      57402    0.00        0      57402   25      14351      71753


                                              ==========================================================================================
PROJECT TOTAL                                                0                             0                       288,584
                                              1,034,522            1,034,522    0.00              1,034,522   28               1,323,106
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ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. 24188A03
FILE NO. 24185A05

** ICEST - INTERACTIVE ESTIMATING **
AP-102 & AP-104 TANK PULSE AIR SYSTEM (42" RISER)
STUDY
DOE_R03 - ESTIMATE BASIS SHEET

PAGE 3 OF 4
DATE 08/28/96 07:49:4?
BY J P H

1. DOCUMENTS AND DRAWINGS

DOCUMENTS: NONE

DRAWINGS: ELEVATION SKETCH OF TANK FARM TANK

2. MATERIAL PRICES

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL. PULSAIR SYSTEMS, BELLEVUE, WA

3. LABOR RATES

A.) ICF-KH HOURLY RATES ARE BASED ON THE 1996 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY ICF KH FINANCE (EFFECTIVE 3-06-96). SEE ALSO ICF FY 1996 PLANNING RATES ? (REPORT RRMP7013).

B.) BASE CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-95). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES, TRAVEL,DEPARTMENTAL OVERHEADS AND G&A/SWT.

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS AND TECHNICAL SERVICES COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE BASED ON THE ICF-KH ESTIMATING FACTORS FOUND IN SECTION 2 OF THE BUDGET GUIDELINE HANDBOOK (BGHB) LOCATED ON HANFORD SOFT REPORTING, FBS BUDGET GUIDELINE HANDBOOK. THE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS 95% FOR SHOP WORK AND FIELD WORK, WHICH IS REFLECTED IN THE "GNRL/ADJ" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION N/A

ESCALATION PERCENTAGES WERE CALCULATED FROM THE JANUARY 1996 UPDATE OF THE ECONOMIC ESCALATION PRICE CHANGE INDICES FOR DOE CONSTRUCTION PROJECTS AS PUBLISHED BY THE "OFFICE OF INFRASTRUCTURE ACQUISITION" FM-50.

6. ROUNDING

U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-32 SUBPARAGRAPH (H), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS (GPP'S) AND LINE ITEM (LI) COST ESTIMATES. REFERENCE: DOE 5100.4, FIGURE I-11, DATED 10-31-84.

7. REMARKS

A.) ASSUME OVERHAUL WILL NOT BE REQUIRED FOR THIS PROJECT.

B.) DEF/DES, ENG/INSP, AND PROJ/MGMT COSTS ARE A PERCENTAGE OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES

C.) TRANSFER PUMPS, COMPRESSORS, PULSAIR EQUIPMENT, TRAILERS, GENERAL REQUIREMENTS COSTS HAVE BEEN DELETED FROM THIS ESTIMATE. (THEY ARE INCLUDED IN ESTIMATE FOR MODIFICATIONS TO 42" RISER)

D.) OTHER PROJECT COSTS WERE INPUT BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES. THE PERCENTAGES FOR THESE EFFORTS WERE DERIVED BASED ON ESTIMATED COSTS FROM PROJECT W-315.

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ICF KAISER HANFORD                              ** TISI - INTERACTIVE ESTIMATING **                      PAGE  4  OF  8
WESTINGHOUSE HANFORD COMPANY               AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)                  DATE  08/28/96 07:02:34
JOB NO. Z4166A03                                              STUDY                                      BY    J P M
FILE NO. 34161A03                                DOE_WBS - COST CODE ACCOUNT SUMMARY

COST                                             ESTIMATE    ONSITE      SUB        ESCALATION        SUB       CONTINGENCY        TOTAL
CODE/WBS            DESCRIPTION                  SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL      TOTAL      %     TOTAL       DOLLARS
=========================================================================================================================================

020  TITLE II DESIGN

141100   DEFINITIVE DESIGN-ONSITE E/C              145000          0     145000   0.00        0     145000   25      36250      181250

   TOTAL 020     TITLE II DESIGN                   145000          0     145000   0.00        0     145000   25      36250      181250

030  TITLE III DESIGN

121000   ENGINEERING/INSPECTION-ONSITE E/C          62000          0      62000   0.00        0      62000   25      15500       77500

   TOTAL 030     TITLE III DESIGN                   62000          0      62000   0.00        0      62000   25      15500       77500

060  PROJECT MANAGEMENT

600000   PROJECT MANAGEMENT                         69000          0      69000   0.00        0      69000   25      17250       86250

   TOTAL 060     PROJECT MANAGEMENT                 69000          0      69000   0.00        0      69000   25      17250       86250

700  SPECIAL EQUIP/PROCESS SYSTEMS

310100   AP 102/104 12" RISER                      265489          0     265489   0.00        0     265489   28      74544      340033
310200   AP 102/104 PULSE AIR SYSTEM               426112          0     426112   0.00        0     426112   30     127835      553947
350000   BURIAL FEE-O/C                              9519          0       9519   0.00        0       9519   30       2854       12373

   TOTAL 700     SPECIAL EQUIP/PROCESS SYSTEM      701120          0     701120   0.00        0     701120   29     205233      906353

900  OTHER PROJECT COSTS

900000   OTHER PROJECT COST                         57402          0      57402   0.00        0      57402   25      14351       71753

   TOTAL 900     OTHER PROJECT COSTS                57402          0      57402   0.00        0      57402   25      14351       71753

                                              ===========================================================================================
PROJECT TOTAL                                                    0                        0                        288,584
                                              1,034,522              1,034,522   0.00             1,034,522   28              1,323,106
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ICF KAISER HANFORD                         ** TEST - INTERACTIVE ESTIMATING **                 PAGE  5  OF  8
WESTINGHOUSE HANFORD COMPANY         SY-102/104 PULSE AIR SYSTEM (THRU 12" RISER)              DATE  08/20/96 07:02:58
JOB NO. [illegible]                                    STUDY                                   BY    J P D
FILE NO. [illegible]                  RPT_A05 - ESTIMATE SUMMARY BY CSI DIVISION

                                            ESTIMATE    ONSITE       SUB       ESCALATION        SUB      CONTINGENCY      TOTAL
 CSI   DESCRIPTION                          SUBTOTAL   INDIRECTS    TOTAL      %      TOTAL      TOTAL     %     TOTAL     DOLLARS
 ----- ---------------------------------- ---------- ---------- ---------- ------ --------- ---------- ----- --------- ----------


CONSTRUCTION

 00   TECHNICAL SERVICES                     264402          0     264402   0.00          0     264402   25      66101     330503
 01   GENERAL REQUIREMENTS                   164112          0     164112   0.00          0     164112   27      44130     208242
 02   SITEWORK                               110895          0     110895   0.00          0     110895   30      33269     144164
 15   MECHANICAL                             426113          0     426113   0.00          0     426113   30     127834     553947
 19   PROJECT MANAGEMENT                      69000          0      69000   0.00          0      69000   25      17250      86250

   TOTAL CONSTRUCTION                                       0                              0                      288,584
                                          1,034,522             1,034,522   0.00              1,034,522   28               1,323,106

                                          ******************************************************************************************
PROJECT TOTAL                                               0                              0                      288,584
                                          1,034,522             1,034,522   0.00              1,034,522   28               1,323,106
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ICF KAISER HANFORD                        ** COST - INTERACTIVE ESTIMATING **                  PAGE  4  OF  8
WESTINGHOUSE HANFORD COMPANY           AP-102 & AP-104 TANK PULSE AIR SYSTEM (12" RISER)       DATE  08/20/96 07.49.54
JOB NO. [illegible]                                      STUDY                                  BY    J P M
FILE NO. [illegible]                    DOE_C06    CONTINGENCY ANALYSIS BASIS SHEET


        REFERENCE:    ESTIMATE BASIS SHEET                                    PAGE  3     OF    8
                      COST CODE ACCOUNT SUMMARY                               PAGE  4     OF    8




             THE U.S. DEPARTMENT OF ENERGY   RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"
        DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A  STUDY      ESTIMATE
        SHOULD HAVE AN OVERALL RANGE OF    20  TO      30% .

        CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE
        LEVEL OF THE DETAILED COST ESTIMATE.


              ENGINEERING  AND MANAGEMENT          DOE COST CODES 020, 030, 060
                           DUE TO THE DEFINITIVE DESIGN AND C/I DURING CONSTRUCTION EFFORTS BEING CALCULATED AT A
              WBS 1.1      PERCENTAGE OF DIRECT CONSTRUCTION AND PROCUREMENT COSTS,  AN OVERALL CONTINGENCY OF 25%
              WBS 1.2      HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                           PLANNING/MANLOADING OF THESE EFFORTS.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA
                           TRACKING AVERAGE DEVIATION OF PROJECT MANAGEMENT COSTS TO DIRECT CONSTRUCTION PROCUREMENT COSTS.


              WBS 4.0      DUE TO THE PROJECT MANAGEMENT EFFORTS BEING CALCULATED AS PERCENTAGE OF OTHER DIRECT COSTS (SEE
                           THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGE METHODOLOGY), AN OVER ALL CONTINGENCY OF 25
                           PERCENTAGE HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                           PLANNING/MANLOADING OF THE EFFORT.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA SHEETS



                               AVERAGE ENGINEERING CONTINGENCY      25%


              CONSTRUCTION
                COST CODE    700      SPECIAL EQUIPMENT PROCESS SYSTEMS
              WBS 2.1
              WBS 3.1              AN AVERAGE CONTINGENCY OF 25% HAS BEEN INCORPORATED INTO EQUIP/PROCESS SYSTEMS DUE
              WBS 3.3              TO INCOMPLETE INFORMATION, SCOPE, SPECIFICATIONS AND DRAWINGS AT THIS TIME.
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ICF KAISER HANFORD                       ** ICES - INTERACTIVE ESTIMATING **                    PAGE   7  OF  8
WESTINGHOUSE HANFORD COMPANY       AP-102 & AP-104 TANK PULSE AIR SYSTEM (12" RISER)           DATE   08/28/96 [illegible]
JOB NO. [illegible]                                     STUDY                                    BY     J P H
FILE NO. [illegible]                DOC_006 - CONTINGENCY ANALYSIS BASIS SHEET


      OTHER PROJECT COSTS WBS COST CODE TOP

         WBS 5.0      DUE TO THE OTHER PROJECT COSTS EFFORTS BEING CALCULATED AS PERCENTAGES OF OTHER DIRECT COSTS
                      (SEE THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGES METHODOLOGY), AN OVERALL CONTINGENCY
                      OF 25% HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                      PLANNING/HANDLOADING OF THESE EFFORTS.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA
                      TRACKING AVERAGE DEVIATION OF OTHER PROJECT COSTS VS DIRECT CONSTRUCTION AND PROCUREMENT COSTS.


                                AVERAGE CONSTRUCTION CONTINGENCY     29%


                                AVERAGE PROJECT CONTINGENCY          28%
```

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ICF KAISER HANFORD                                   ** TEST - INTERACTIVE ESTIMATING **                       PAGE   1  OF   1
WESTINGHOUSE HANFORD COMPANY                     AP-102/104 PULSE AIR SYSTEM (NEW 12" RISER)                   DATE   06/28/94 07:02:42
JOB NO. 24740AA5                                                 SUMMT                                         BY     J P N
FILE NO. 24765A03                                  #04_L07 - ONSITE INDIRECT COSTS BY WBS

                                                              ESTIMATE     CONTRACT ADMINISTRATION     BID PACK       OTHER          TOTAL
WBS     DESCRIPTION                                           SUBTOTAL          %          TOTAL         PREP.      INDIRECTS      INDIRECTS
------  --------------------------------------------------   --------       -----    ---------     ---------     ---------      ---------

111100 DEFINITIVE DESIGN-ONSITE A/E                             145000         0.00            0             0             0              0
121000 ENGINEERING/INSPECTION-ONSITE I/C                         42000         0.00            0             0             0              0
310100 AP 102/104 12" RISER                                     265409         0.00            0             0             0              0
311200 AP 102/104 PULSE AIR SYSTEM                              426112         0.00            0             0             0              0
330000 BURIAL FEE-O/C                                             9519         0.00            0             0             0              0
600000 PROJECT MANAGEMENT                                        89000         0.00            0             0             0              0
900000 OTHER PROJECT COST                                        57482         0.00            0             0             0              0

                                                       ===========================================================================================
PROJECT TOTAL                                               1,034,522                                        0                            0
                                                                                            0                              0
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ICF KAISER HANFORD                              ** IES - INTERACTIVE ESTIMATING **                 PAGE       1
WESTINGHOUSE HANFORD COMPANY                 AP-102/104 PULSE AIR SYSTEM (ONLY 12" RISER)          DATE   08/28/96 07:02:45
JOB NO. 34165A03                                             SHORT                                 BY     J P N
FILE NO. 24165A03                            WBS_600 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                          COST                                    EQUIP             SUB-     EQUIP-     OH&P      TOTAL
NUMBER         DESCRIPTION                       CODE  QUANTITY  MANHOURS    LABOR     USAGE  MATERIAL  CONTRACT     MENT   / F E E   DOLLARS
============== ================================ ==== ========== ======== ========= ======== ========= ======== ======== ======== =========

111100         DEFINITIVE DESIGN-ONSITE E/C

111100.00      TECHNICAL SERVICES
111100.020200A DEFINITIVE DESIGN                 020        1 LS        0         0         0        0   145000        0         0    145000
                                                     -----------------------------------------------------------------------------------------
    SUBTOTAL   TECHNICAL SERVICES                                        0                   0           145,000                  0
                                                                                   0                   0                   0               145,000
                                                     -----------------------------------------------------------------------------------------
    TOTAL      COST CODE 020A0                                           0                   0           145,000                  0
               WBS 111100                                                          0                   0                   0               145,000
               (ESCALATION    0.00% - CONTINGENCY  25.00 %)


                                                     -----------------------------------------------------------------------------------------
  TOTAL WBS 111100 DEFINITIVE DESIGN-ONSITE E/C                          0                   0           145,000                  0
                                                                                   0                   0                   0               145,000
```

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ICF KAISER HANFORD                        ** BEST - INTERACTIVE ESTIMATING **              PAGE      2
WESTINGHOUSE HANFORD COMPANY           AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)        DATE  06/28/96 07:03:45
JOB NO. 24161A03                                      STUDY                                BY     J P M
FILE NO. 24161A03                      DOE_A06 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                       EQUIP              SUB-     EQUIP-     MARP       TOTAL
NUMBER         DESCRIPTION                      CODE  QUANTITY  MANHOURS     LABOR         USAGE   MATERIAL  CONTRACT    MENT     / D & I    DOLLARS
-------------- -------------------------------- ---- ---------- -------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

121000         ENGINEERING/INSPECTION-ONSITE E/C

121000.00      TECHNICAL SERVICES
121000.00000054 ENGINEERING INSPECTION          056         1 LS         0          0          0          0      62000          0          0      62000
                                                     --------------------------------------------------------------------------------------------------
     SUBTOTAL  TECHNICAL SERVICES                                        0                     0                 62,000                     0
                                                                                    0                     0                     0                 62,000
                                                     --------------------------------------------------------------------------------------------------
     TOTAL     COST CODE 02000                                           0                     0                 62,000                     0
               WBS 121000                                                           0                     0                     0                 62,000
               ESCALATION   0.00% - CONTINGENCY  25.00 %

                                                     --------------------------------------------------------------------------------------------------
   TOTAL WBS 121000 ENGINEERING/INSPECTION-ONSITE E/C                    0                     0                 62,000                     0
                                                                                    0                     0                     0                 62,000
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ICF KAISER HANFORD                            ** ICES - INTERACTIVE ESTIMATING **                       PAGE       5
WESTINGHOUSE HANFORD COMPANY              AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)                   DATE   08/28/94 07:02:45
JOB NO. [illegible]                                         STUDY                                        BY     J P M
FILE NO. [illegible]                      900_000 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                          COST                                      EQUIP                 SUB-     EQUIP-      ONRP      TOTAL
NUMBER          DESCRIPTION                      CODE  QUANTITY   MANHOURS     LABOR       USAGE    MATERIAL  CONTRACT      RENT     / B & I   DOLLARS
--------------  ------------------------------- ----  ---------  --------  ---------  --------  ---------  --------  --------  --------  ---------

310100          AP 102/104 12" RISER

310100.01       GENERAL REQUIREMENTS
310100.0110104  ******************************  700 F        0          0          0         0          0         0         0         0          0
                     GENERAL REQUIREMENTS
                ******************************
310100.0110106  STEP OFF PAD SUPPORT            700 F      820 HR     820      31381         0          0         0         0     16118      47499
                 @220 HRS, LEAD FIELD HRS
                (277 & STEP OFF PAD WRK @20
                =4137 DIV BY 10 MAN CREW =
310100.0110108  410 CREW HRS TIMES  2 EACH      700 F        0          0          0         0          0         0         0         0          0
                SUPPORT ATTENDENTS
                                                --------------------------------------------------------------------------------------------
     SUBTOTAL   GENERAL REQUIREMENTS            (70001)             820                    0                    0                16,118
                                                                              31,381                   0                   0                47,499
                GENERAL FOREMAN   7.00 %                             57        2196                                                           2196
                ONRP (ON MARKUPS ONLY)                                                                                             1342       1342
                ............................................................................................................
     TOTAL      COST CODE 70001                                     877                    0                    0                17,460
                WBS 310100                                                    33,577                   0                   0                51,037
                (ESCALATION   0.00% - CONTINGENCY  20.00 %)

310100.01       GENERAL REQUIREMENTS
310100.0115004  ******************************  700 W        4 EA        0          0         0          0         0         0         0          0
                     GARAGE STRUCTURE
                ******************************
310100.0115006  ALLOW FOR FRAMING        CARP   700 W      240 HRS     240      10541         0       4500         0         0      5410      20451
                (SIZE OF STRUCTURES UNKNOWN)
                4 EACH GARAGE
310100.0115008  ALLOW FOR LIGHT FIXTURES LAB    700 W      160 HRS     160       6089         0       3000         0         0      3582      12671
                (SIZE OF STRUCTURES UNKNOWN)
310100.0115010  ALLOW FOR ELEC SUPPORT          700 W      100 HRS     100       5264         0          0         0         0      2717       7981
                (SIZE OF STRUCTURES UNKNOWN)
310100.0115012  ALLOW FOR HVAC SUPPORT          700 W       80 HRS      80       3994         0      12000         0         0      2077      18071
                (SIZE OF STRUCTURES UNKNOWN)
                HEPA FILTERS AND FRESH AIR
                MAKE UP
310100.0115102  ALLOW FOR STRUCTURE DECON       700 W      120 HRS     120       6502         0          0         0         0      3388       9890
                (SIZE OF STRUCTURES UNKNOWN)
310100.0115104  ALLOW FOR BURIAL PACKAGING      700 W       60 HRS      60       2276         0       4000         0         0      1194       7470
                (SIZE OF STRUCTURES UNKNOWN)
                (INCL 4 EA 4X4X8 WOOD BOXES
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ICF KAISER HANFORD                             ** ICES - INTERACTIVE ESTIMATING **                 PAGE      4
WESTINGHOUSE HANFORD COMPANY               AP-102/104 PULSE AIR SYSTEM (TWO 12" RISERS)            DATE   08/26/96 07:02:44
JOB NO. 25161AD3                                             STUDY                                 BY     [illegible]
FILE NO. 26161AD3                          DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                       COST                                   EQUIP                SUB-    EQUIP-      OH&P      TOTAL
NUMBER         DESCRIPTION                    CODE  QUANTITY  MANHOURS     LABOR     USAGE  MATERIAL  CONTRACT     MENT    / B & L    DOLLARS
-------------- ------------------------------ ---- ---------- -------- --------- --------- --------- --------- --------- --------- ---------

                                                   -----------------------------------------------------------------------------------------
    SUBTOTAL   GENERAL REQUIREMENTS           (SWP)                780                 0                   0                17,428
                                                                          33,398              25,500                 0                76,326
               SWP    40.00%                                       312     13604                                                       13604
               GENERAL FOREMAN    7.00 %                            76      3204                                                        3204
               CONSUMABLES   6.00 %                                                             1530                                    1530
               SALES TAX    8.00 %                                                              2162                 0                  2162
               WAREHOUSING  28.00 %                                                             7568                                    7568
               OH&P (ON MARKUPS ONLY)                                                                                         8679      8679
                                                   -----------------------------------------------------------------------------------------
    TOTAL      COST CODE 70001                                   1,168                 0                   0                26,107
               WBS 310100                                                 50,206              36,760                 0               113,073
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

310100.02      SITEWORK
310100.0237204 ****************************** 700 W         0        0         0         0         0         0         0         0         0
                AP 102/104    TRENCH LIGHT
                  12" RISERS TO MANIFOLD
               ******************************
310100.0232205 VACUUM EXCAVATION  (GUZZLER)   700 W     56 HR       56      2143         0      1000         0         0      1114      4257
310100.0232206 TRENCH 5 X 3 X 250    NEAT     700 W     85 CY      415     15082         0         0         0         0      9259     24341
               NO SHORE NO ANGLE OF REPOSE
310100.0232237 PLACE B-FILL                   700 W     85 CY      249      9529         0         0         0         0      4955     14484
310100.0232236 ALLOW FOR FINE GRADE AND       700 W     45 CY      344     15908         0       675         0         0      8272     24855
               STABILIZE
                                                   -----------------------------------------------------------------------------------------
    SUBTOTAL   SITEWORK                       (SWP)              1,080                 0                   0                23,600
                                                                          42,662               1,675                 0                67,937
               SWP    40.00%                                       432     17304                                                       17304
               GENERAL FOREMAN    7.00 %                           105      4250                                                        4250
               CONSUMABLES   6.00 %                                                              100                                     100
               SALES TAX    8.00 %                                                               142                 0                   142
               WAREHOUSING  28.00 %                                                              497                                     497
               OH&P (ON MARKUPS ONLY)                                                                                        11256     11256
                                                   -----------------------------------------------------------------------------------------
    TOTAL      COST CODE 70002                                   1,617                 0                   0                34,856
               WBS 310100                                                 64,106               2,414                 0               101,375
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

                                                   -----------------------------------------------------------------------------------------
  TOTAL WBS 310100 AP 102/104 12" RISER                          3,043                 0                   0                77,428
                                                                         140,000              39,175                 0               245,400
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ICF KAISER HANFORD                          ** ICEST - INTERACTIVE ESTIMATING **                      PAGE      5
WESTINGHOUSE HANFORD COMPANY              AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)                DATE  08/20/96 07:02:46
JOB NO. 14141A03                                            STUDY                                     BY    J P M
FILE NO. 74?6SA03                         DOE_ADS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                    EQUIP                        SUB-     EQUIP-      OH&P      TOTAL
NUMBER          DESCRIPTION                     CODE  QUANTITY  MANHOURS    LABOR       USAGE   MATERIAL  CONTRACT     MENT   / G & A   DOLLARS
--------------  ------------------------------  ----  --------  --------  --------  --------  --------  --------  --------  --------  --------

310200          AP 102/104 PULSE AIR SYSTEM

310200.15       MECHANICAL
310200.1526006  ******************************  700 F     4 EA         0         0         0         0         0         0         0         0
                 AP 102/104    FIELD FAB 2"
                RISER W/ 10" PULSAIR UNIT
                ******************************
310200.1524004  FABRICATE SHIELD PLUG           700 F     6 EA       510     27234         0      3000         0         0     14162     44396
                ABSTRACTED FROM ACTUAL RISER
                COSTS FOR W-151 PROJECT
                (LABOR & MAT'L $45,000.00)
310200.1524010  DRILL 2-1/2"DIA. HOLE IN 12"    700 F     6 HOL         96      5126         0         0         0         0      2666      7792
                C/S FLANGE
310200.1524012  12" DBL GSKT   (BOLT-UP)        700 F     4 SET         13       694         0       240         0         0       361      1295
310200.1524016  2" WN SST 150# FLANGE           700 F    17 EA        10       534         0      1680         0         0       278      2492
310200.1524018  2" SST JUMPER NOZZLE            700 F     4 EA         6       320         0      2016         0         0       164      2502
310200.1524020  2"  SCH 40 SST PIPE             700 F   500 LF        57      3044         0     12000         0         0      1583     16627
310200.1524026  2"  SST FIELD WELDS             700 F    30 EA       189     10093         0         0         0         0      5250     15343
310200.1524027  WELD AIR DISTRIBUTOR HEAD       700 F     4 EA        66      3524         0         0         0         0      1832      5356
                TO RISER PIPE
310200.1524030  WELD 2" SST RISER TO OPNG       700 F     4 EA        18       961         0         0         0         0       500      1461
                IN 12" FLANGE
310200.1524052  4" O.D. X 2.5" I.D. SST RINGS   700 F    24 EA        48      2563         0       192         0         0      1333      4088
310200.1524056  1/4" X 1/2" SST PLATE           700 F   310 LF        61      3257         0      1530         0         0      1694      6481
310200.1526034  TACK WELD SST PLATE TO          700 F   400 LF        72      3845         0         0         0         0      1999      5844
                EXTERIOR OF 2" RISER PIPE
310200.1526038  HYDRO TEST RISER                700 F     4 JOB       48      2563         0         0         0         0      1333      3896
                                                      ---------------------------------------------------------------------------------------
      SUBTOTAL  MECHANICAL                            (FIELD)      1,194                   0                           0               33,155
                                                                           63,758              20,658                        0               117,571
                GENERAL FOREMAN   7.00 %                              83      4463                                                           4463
                CONSUMABLES   6.00 %                                                             1239                                        1239
                SALES TAX   8.00 %                                                               1751                        0               1751
                WAREHOUSING  28.00 %                                                             6131                                        6131
                OH&P (OR MARKUPS ONLY)                                                                                               2320      2320
                                                      ---------------------------------------------------------------------------------------
      TOTAL     COST CODE 700FS                                    1,277                   0                           0               35,475
                WBS 310200                                                 68,221              29,780                        0               133,477
                (ESCALATION   0.00% - CONTINGENCY  30.00 %)

310200.13       MECHANICAL
310200.1524104  ******************************  700 M     4 EA         0         0         0         0         0         0         0         0
                 AP 102/104    INSTALL    2"
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ICF KAISER HANFORD                           ** TEST - INTERACTIVE ESTIMATING **                  PAGE        4
WESTINGHOUSE HANFORD COMPANY              AP-102/104 PULSE AIR SYSTEM (THRU 12" RISERS)           DATE   08/26/96 07:02:46
JOB NO. 24165A03                                          STUDY                                   BY      J P M
FILE NO. 24165A03                         DOC_### - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                          COST                                     EQUIP               SUB-      EQUIP-      OH&P       TOTAL
NUMBER         DESCRIPTION                       CODE  QUANTITY  MANHOURS     LABOR       USAGE   MATERIAL  CONTRACT    MENT      / B & T    DOLLARS
-------------- --------------------------------- ---- ---------- -------- ---------- -------- ---------- --------- --------- ---------- ----------

               RISER W/AIR DISTR (ON MASK)
               ----------------------------------
310200.1526106 REMOVE 12" RISER W/FLANGE         700 M      4 EA      144       7690        0          0         0         0       5999      13689
               AP 102/104
310200.1526108 CRANE OPERATOR SUPPORT            700 M      4 EA       72       3182        0          0         0         0       1635       4817
310200.1526110 DECON AND PACKAGE W/FLANGE        700 M      5 EA       24        918        0        330         0         0        477       1725
               FULL BURIAL DRUM
               (WOULD USE 3  DRUMS FOR 6 EA
               BLIND FLANGES)
310200.1526112 PLACE 12" SHIELD PLUG             700 M      6 EA      192      10253        0          0         0         0       5332      15585
310200.1526114 CRANE OPERATOR SUPPORT            700 M      4 EA       96       4242        0          0         0         0       2206       6448
310200.1526116 PLACE DISTRIBUTORS W/SST          700 M      6 EA      192      10253        0          0         0         0       5332      15585
               RISER AND 12" FLANGE
310200.1526118 CRANE OPERATOR SUPPORT            700 M      4 EA       96       4242        0          0         0         0       2206       6448
310200.1526120 BOLT UP 12" FLANGE                700 M      4 EA       13        694        0         72         0         0        361       1127
                                                      -------------------------------------------------------------------------------------
      SUBTOTAL  MECHANICAL                          (MASK)            829                 0                    0                 23,548
                                                                             41,474                402                   0                 65,424
               SWF  100.00%                                           829      41474                                                         41474
               GENERAL FOREMAN    14.00 %                             116       5806                                                          5806
               CONSUMABLES    6.00 %                                                               24                                            24
               SALES TAX    8.00 %                                                                 34                   0                        34
               WAREHOUSING  28.00 %                                                               119                                           119
               OH&P (ON MARKUPS ONLY)                                                                                                24505     24505
                                                      -------------------------------------------------------------------------------------
      TOTAL     COST CODE 70015                                     1,774                 0                    0                 48,053
               WBS 310200                                                    88,754                579                   0                153,407
               (ESCALATION    0.00% - CONTINGENCY  30.00 %)

310200.15      MECHANICAL
310200.1526120 *******************************   700 W      0               0          0        0          0         0         0          0          0
                  AP 102/104 INSTALL PIPING
                   COMPONENT   (ON WBS-3)
               *******************************
310200.1526121 ALLOWANCE FOR CONCRETE PAD        700 W      6 EA      720      31442        0       3000         0         0      16350      50792
               AT SURFACE FOR LOCATION
               MARKER AND REEL SUPPORT
310200.1526122 PROVIDE HARD PIPING AT RISER      700 W      6 EA      240      12016        0      18000         0         0       6464      36480
               TO INCLUDE W/ELBOW PT/E AND
               HOSE CONNECTIONS AND
               NECESSARY FTGS. (ALLOWANCE)
310200.1526130 2" HOSE                           700 W    200 LF       38       1600        0       6400         0         0        835       8835
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ICF KAISER HANFORD                          ** TEST - INTERACTIVE ESTIMATING **                        PAGE        7
WESTINGHOUSE HANFORD COMPANY             AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)                  DATE   08/20/96 07:02:46
JOB NO. 26105A03                                             STUDY                                     BY     J F M
FILE NO. 31165A05                        WBS_R06 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                        EQUIP                 SUB-     EQUIP-      OH&P      TOTAL
NUMBER          DESCRIPTION                     CODE   QUANTITY   MANHOURS    LABOR     USAGE   MATERIAL  CONTRACT    MENT     / B & I   DOLLARS
--------------- ------------------------------- ---- ---------- -------- -------- -------- -------- -------- -------- -------- ---------

310200.1524152 ALLOWANCE FOR 2" HOSE FTGS      700 W       6 EA       26     1387        0     3000        0        0      582      4969
310200.1524154 ALLOWANCE FOR MANIFOLD PIPE     700 W       1 LS       32     1707        0      500        0        0      887      3094
310200.1524150 ALLOWANCE FOR MECHANICAL AIP    700 W       2 LS       16      854        0        0        0        0      444      1298
                                                     --------------------------------------------------------------------------------
    SUBTOTAL   MECHANICAL                            (EVP)           1,082                 0                   0            25,847
                                                                             49,705            30,500                   0           106,052
               SWP   40.00%                                            424    19882                                                  19882
               GENERAL FOREMAN    7.00 %                               104     4871                                                   4871
               CONSUMABLES    6.00 %                                                             1830                                 1830
               SALES TAX    8.00 %                                                               2586                 0               2586
               WAREHOUSING  28.00 %                                                              9052                                 9052
               OH&P (ON MARKUPS ONLY)                                                                                         12871   12871
                                                     ................................................................................
    TOTAL      COST CODE 70015                                       1,590                 0                   0            38,718
               WBS 310200                                                    74,458            43,968                   0           157,144
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

                                                     ................................................................................
 TOTAL WBS 310200 AP 102/104 PULSE AIR SYSTEM                        6,642                 0                   0           120,340
                                                                            331,433            74,320                   0           626,110
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ICF KAISER HANFORD                        ** ICES - INTERACTIVE ESTIMATING **                          PAGE      8
WESTINGHOUSE HANFORD COMPANY         AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)                      DATE  08/20/96 07:02:44
JOB NO. 24106A03                                     STUDY                                             BY    J P H
FILE NO. 24105LD5                    WBS_R08 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                      COST                                    EQUIP                SUB-     EQUIP-      OSAP       TOTAL
NUMBER         DESCRIPTION                   CODE  QUANTITY  MANHOURS     LABOR      USAGE   MATERIAL  CONTRACT      MENT     / G & I    DOLLARS
-------------- ----------------------------- ---- ---------- -------- --------- --------- ---------- --------- --------- --------- ----------

330000         BURIAL FEE-O/C

330000.02      SITEWORK
330000.0270004 4 X 4 X 8 BURIAL BOX (4 EA)   700     552 CF         0         0         0          0      9144         0         0       9144
               ABV/AGE STRUCTURES
330000.0270014 BURIAL DRUM          (3  EA)  700      21 CF         0         0         0          0       375         0         0        375
               FOR RISER BLIND FLANGES
                                                  ------------------------------------------------------------------------------------------
    SUBTOTAL   SITEWORK                                             0                   0                9,519                   0
                                                                              0                    0                     0                9,519
                                                  ------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70002                                      0                   0                9,519                   0
               WBS 330000                                                     0                    0                     0                9,519
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

                                                  ------------------------------------------------------------------------------------------
  TOTAL WBS 330000 BURIAL FEE-O/C                                   0                   0                9,519                   0
                                                                              0                    0                     0                9,519
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ICF KAISER HANFORD                         ** TEST - INTERACTIVE ESTIMATING **                     PAGE      4
WESTINGHOUSE HANFORD COMPANY          AP-102/104 PULSE AIR SYSTEM (THRU 12" RISERS)                DATE  08/20/96 09:02:40
JOB NO. 24146AD3                                           STUDY                                   BY    J P M
FILE NO. 24146AD3                     DOE_R4B - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                      COST                                  EQUIP                   SUB-      ENVIR-     OWNR      TOTAL
NUMBER          DESCRIPTION                  CODE  QUANTITY  MANHOURS    LABOR     USAGE   MATERIAL CONTRACT     MENT     F & A I   DOLLARS
=============== ============================ ==== ========== ========= ========= ======== ========= ========= ========= ========= =========

600000          PROJECT MANAGEMENT

600000.10       PROJECT MANAGEMENT
600000.1000006  PROJECT MANAGEMENT           040        1 LS         0         0        0         0     69000         0         0     69000
                                                  ---------------------------------------------------------------------------------------
     SUBTOTAL   PROJECT MANAGEMENT                                   0                  0               69,000                  0
                                                                               0                  0                   0                69,000
                                                  ---------------------------------------------------------------------------------------
     TOTAL      COST CODE 06019                                      0                  0               69,000                  0
                WBT 600000                                                     0                  0                   0                69,000
                (ESCALATION   0.00% - CONTINGENCY  25.00 %)

                                                  ---------------------------------------------------------------------------------------
   TOTAL WBS 600000 PROJECT MANAGEMENT                               0                  0               69,000                  0
                                                                               0                  0                   0                69,000
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ICF KAISER HANFORD                        ** ICES - INTERACTIVE ESTIMATING **                 PAGE      16
WESTINGHOUSE HANFORD COMPANY           AY-102/104 PULSE AIR SYSTEM (THRU 12" RISER)           DATE  08/26/96 07:27:46
JOB NO. [illegible]                                      STUDY                                BY    J F M
FILE NO. [illegible]                   DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                        COST                                  EQUIP              SUB-    EQUIP-    OH&P     TOTAL
NUMBER        DESCRIPTION                      CODE  QUANTITY  MANHOURS    LABOR     USAGE  MATERIAL CONTRACT     MENT   / B & I  DOLLARS
------------- ------------------------------ ---- ---------- -------- -------- -------- -------- -------- -------- -------- ---------

500000        OTHER PROJECT COST

500000.00     TECHNICAL SERVICES
500000.0000006 PERMITTING & SAFETY            900        1 LS        0        0        0        0     1383        0        0      1383
              BASED ON 2 PERCENTAGE OF
              DIRECT CONSTRUCTION LESS
              BURIAL COST
500000.0000008 OPC ACTIVITIES                 900        1 LS        0        0        0        0    52561        0        0     52561
              BASED ON 7% PERCENTAGE OF
              DIRECT CONSTRUCTION LESS
              BURIAL COST
500000.0000010 WHC SUPPORT                    900        1 LS        0        0        0        0     3458        0        0      3458
              BASED ON  3  PERCENTAGE OF
              DIRECT CONSTRUCTION LESS
              BURIAL COST
                                                    -------------------------------------------------------------------------------
    SUBTOTAL  TECHNICAL SERVICES                                     0                 0            57,402                 0
                                                                              0                 0                 0             57,402
                                                    -------------------------------------------------------------------------------
    TOTAL     COST CODE 900
              WBS 500000                                             0                 0            57,402                 0
              (ESCALATION   0.00% - CONTINGENCY  25.00 %)                     0                 0                 0             57,402

                                                    -------------------------------------------------------------------------------
  TOTAL WBS 500000 OTHER PROJECT COST                                0                 0            57,402                 0
                                                                              0                 0                 0             57,402
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ICF KAISER HANFORD                                    ** ICES - INTERACTIVE ESTIMATING **                    PAGE       11
WESTINGHOUSE HANFORD COMPANY                        AP-102/104 PULSE AIR SYSTEM (THRU 12" RISER)             DATE   08/26/96 07:02:46
JOB NO. 24186A03                                                    STUDY                                    BY     J P M
FILE NO. 24161A05                                   DOE_RPT - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                             COST                                  EQUIP                  SUB-    CONTIN-    OVHD      TOTAL
NUMBER         DESCRIPTION                          CODE  QUANTITY  MANHOURS     LABOR    USAGE  MATERIAL CONTRACT    GENCY   / G & A   DOLLARS
-------------- ------------------------------------ ---- --------- --------- --------- -------- -------- -------- -------- -------- --------


REPORT TOTAL                                                           8,386                 0            342,821             197,770
                                                                                380,524           113,506              0           1,034,527
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ICF KAISER HANFORD                          ** JEST - INTERACTIVE ESTIMATING **            PAGE  1  OF  8
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM            DATE  09/03/96 07:45:22
JOB NO. [illegible]                                     STUDY                               BY    J P H
FILE NO. [illegible]                        DOE_DOC - PROJECT COST SUMMARY


              COST                                              ESCALATED        CONTINGENCY           TOTAL
              CODE     DESCRIPTION                              TOTAL COST      %        TOTAL        DOLLARS
              -----    -----------------------------------     -----------    -----  ------------  ------------

              020      TITLE II DESIGN                             930,000     25        230,000     1,160,000
              030      TITLE III DESIGN                            400,000     25        100,000       500,000
              [illegible]      PROJECT MANAGEMENT                  440,000     25        110,000       550,000
                        (ADJUSTED TO MEET DOE 5100.4)               30,000               -40,000       -10,000
                                                              ----------------------------------------------------
              TOTAL DESIGN AND MANAGEMENT                        1,800,000     22        400,000     2,200,000
                        (ADJUSTED TO MEET DOE 5100.4)

              700      SPECIAL EQUIP/PROCESS SYSTEMS             6,070,000     23      1,400,000     7,470,000
                        (ADJUSTED TO MEET DOE 5100.4)               10,000                20,000        30,000
                                                              ----------------------------------------------------
              TOTAL CONSTRUCTION                                 6,100,000     23      1,400,000     7,500,000

              TOTAL ESTIMATED CONSTRUCTION COST (TECC)           7,900,000 [illegible] 1,800,000     9,700,000


              900      OTHER PROJECT COSTS                       3,680,000 [illegible]   920,000     4,600,000
                        (ADJUSTED TO MEET DOE 5100.4)               20,000               -20,000             0
                                                              ----------------------------------------------------
              TOTAL OTHER PROJECT COSTS    (OPC)                 3,700,000     24        900,000     4,600,000

                                                              ----------------------------------------------------

              TOTAL PROJECT COSTS  (TPC)                        11,600,000     23      2,700,000    14,300,000

-------------------------------------------------------------------------------------------------------------------
| TYPE OF                                                      | REMARKS:
| ESTIMATE              STUDY ESTIMATE   SEPTEMBER 3, 1996     |
|--------------------------------------------------------------|    PROJECT SCHEDULE WAS NOT PROVIDED.  THEREFORE ESCALATION
| ARCHITECT                                                    |    HAS BEEN OMITTED FROM ESTIMATE.
| ENGINEER                                9-3-96               |
|--------------------------------------------------------------|
| OPERATING                                                    |
| CONTRACTOR                                                   |
|--------------------------------------------------------------|
|                                                              |
-------------------------------------------------------------------------------------------------------------------
            (ROUNDED/ADJUSTED TO THE NEAREST - 10,000 / 100,000 - - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)
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CHECK

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ICF KAISER HANFORD                        ** ICE - INTERACTIVE ESTIMATING **                  PAGE  2  OF  8
WESTINGHOUSE HANFORD COMPANY             AP-102 & AP-104 TANK PULSE AIR SYSTEM                DATE  09/03/96 07:43:25
JOB NO. E416SACA                                        STUDY                                 BY    J P M
FILE NO. E416SACA                      WBS_002 - WORK BREAKDOWN STRUCTURE SUMMARY


                                             ESTIMATE    ONSITE       SUB       ESCALATION        SUB      CONTINGENCY        TOTAL
 WBS    DESCRIPTION                          SUBTOTAL   INDIRECTS    TOTAL      %      TOTAL     TOTAL     %      TOTAL      DOLLARS
------ ----------------------------------  ---------- ----------- ---------- ------ --------- ---------- ----- ---------- ----------

111000 DEFINITIVE DESIGN-ONSITE E/C            931000           0     931000   0.00         0     931000    25     232750    1163750
121000 ENGINEERING/INSPECTION-ONSITE E/C       399000           0     399000   0.00         0     399000    25      99750     498750

  SUBTOTAL 1      ENGINEERING                 1330000           0    1330000   0.00         0    1330000    25     332500    1662500


210000 PROCUREMENT-ONSITE E/C                 1127452           0    1127452   0.00         0    1127452    30     338236    1465688

  SUBTOTAL 2      PROCUREMENT                 1127452           0    1127452   0.00         0    1127452    30     338236    1465688


510100 AP 102/104 CENTRAL PUMP PIT PREP        225000           0     225000   0.00         0     225000    20      46191     280279
510200 AP 102/104 PULSE AIR SYSTEM             174639           0     174639   0.00         0     174639    30      52391     227030
510400 DECANT PUMP INSTALLATION                321734           0     321734   0.00         0     321734    25      77961     397427
510600 CONTAMINATED EQUIPMENT REMOVAL         3713870           0    3713870   0.00         0    3713870    20     742774    4456644

  SUBTOTAL 51     FA CONST-ONSITE E/C         4435531           0    4435531   0.00         0    4435531    21     934919    5370450


530000 BURIAL FEE-O/C                          483210           0     483210   0.00         0     483210    30     144963     628173

  SUBTOTAL 53     BURIAL FEE-O/C               483210           0     483210   0.00         0     483210    30     144963     628173

  SUBTOTAL 3      CONSTRUCTION                4918541           0    4918541   0.00         0    4918541    22    1079882    5998623


400000 PROJECT MANAGEMENT                      443000           0     443000   0.00         0     443000    25     110750     553750

  SUBTOTAL 4      PROJECT INTEGRATION          443000           0     443000   0.00         0     443000    25     110750     553750


500000 OTHER PROJECT COSTS                    3679000           0    3679000   0.00         0    3679000    25     919750    4598750

  SUBTOTAL 5      OTHER PROJECT COST          3679000           0    3679000   0.00         0    3679000    25     919750    4598750


                                            ==========================================================================================
PROJECT TOTAL                                               0                          0                       2,781,118
                                           11,497,993             11,497,993   0.00             11,497,993    24              14,279,311
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ICF KAISER HANFORD                     ** ICES - INTERACTIVE ESTIMATING **                   PAGE  5  OF  [illegible]
WESTINGHOUSE HANFORD COMPANY           AP-102 & AP-104 TANK PULSE AIR MIXING                 DATE  [illegible]
JOB NO. [illegible]                                   STUDY                                  BY    J P M
FILE NO. [illegible]                      DOE_HQ? - ESTIMATE BASIS SHEET

1. DOCUMENTS AND DRAWINGS
   ----------------------
   DOCUMENTS:        NONE

   DRAWINGS:         ELEVATION  SKETCH OF TANK FARM TANK

2. MATERIAL PRICES
   ---------------
   UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.  PULSAIR SYSTEMS, BELLEVUE, WA

3. LABOR RATES
   -----------
   A.) ICF-KH HOURLY RATES ARE BASED ON THE 1996 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE
       (EFFECTIVE 3-08-96). SEE ALSO "WHC FY 1996 PLANNING RATES " (REPORT [illegible]).
   B.) BASE CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-95). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES,
       TRAVEL,DEPARTMENTAL OVERHEADS AND G&A/DUS.


4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS
   -------------------------------------------------
   A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS AND TECHNICAL SERVICES COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE
       BASED ON THE ICF-KH ESTIMATING FACTORS FOUND IN SECTION 2 OF THE BUDGET GUIDELINE HANDBOOK (KGHB) LOCATED ON HANFORD SOFT
       REPORTING, FDS BUDGET GUIDELINE HANDBOOK. THE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS
       52% FOR SHOP WORK AND FIELD WORK, WHICH IS REFLECTED IN THE "GNRP/ALL" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION   N/A
   ----------

6. ROUNDING
   ------------------------
   U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-37 SUBPARAGRAPH (M), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS
   (GPP'S) AND LINE ITEM (LI) COST ESTIMATES, REFERENCE: DOE 5100.4, FIGURE I-11, DATED 10-31-84.

7. REMARKS
   -------
   A.) ASSUME BURIAL WILL NOT BE REQUIRED FOR THIS PROJECT.
   B.) PRE/DES, ENG/INSP, AND PROJ/MGMT COSTS ARE A PERCENTAGE OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES
   C.) THERMOCOUPLE AND CCTV COSTS HAVE BEEN ABSTRACTED FROM PROJECT NUMBER W-211.
   D.) LABOR AND MATERIAL COSTS FOR TRANSFER RISER PUMP HAVE BEEN ABSTRACTED FROM PROJECT NUMBER W-211
   E.) ASSUME ELECTRICAL POWER CONNECTION TO BE INSTALLED ABOVE GROUND AT EXISTING POWER POLE RISER WITH ACCEPTABLE PLUG IN;
       NEW COMPRESSOR WILL PLUG IN ABOVE GROUND ADJACENT TO COMPRESSOR.
   F.) AS DIRECTED BY ONSITE CONTRACTOR,  INSTALLATION OF NEW JUMPER WILL BE TO EXISTING NOZZLE IN CENTRAL PUMP PIT.
   G.) ASSUMED THAT "GUZZLER" WILL BE USED FOR EXCAVATION TASKS.  GUZZLER PRODUCTION/HAND EXCAVATION RATES WERE OBTAINED
       FROM PROJECT W-030.
   H.) EXCAVATED SOIL WILL BE REUSED AS BACKFILL.
   I.) OTHER PROJECT COSTS WERE INPUT BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES.
   J.) DEFINITIVE DESIGN COSTS ARE 21% OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES, PERCENTAGE IS BASED ON HANFORD HISTORICAL DATA
   K.) ENG/INSPECTION    COSTS ARE  9% OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES, PERCENTAGE IS BASED ON HANFORD HISTORICAL DATA
   L.) PROJ/MANAGEMENT   COSTS ARE 10% OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES.
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ICF KAISER HANFORD                             ** TEST - INTERACTIVE ESTIMATING **                      PAGE  4  OF  8
WESTINGHOUSE HANFORD COMPANY                  AP-102 & AP-104 TANK PULSE AIR SYSTEM                     DATE  09/05/94 07:43:21
JOB NO. ZG100AC6                                              STUDY                                     BY    J P M
FILE NO. ER1034C6                              DOE_004 - COST CODE ACCOUNT SUMMARY

COST                                           ESTIMATE    ONSITE       SUB       ESCALATION        SUB      CONTINGENCY       TOTAL
CODE/WBS           DESCRIPTION                 SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL      TOTAL     %     TOTAL      DOLLARS
---------------------------------------------- ---------  ----------  ---------  ------ --------  ---------  ----- ---------  ---------

020  TITLE II DESIGN

111100   DEFINITIVE DESIGN-ONSITE E/C            931000          0     931000   0.00        0     931000   25     232750    1163750

   TOTAL 020     TITLE II DESIGN                 931000          0     931000   0.00        0     931000   25     232750    1163750

030  TITLE III DESIGN

121000   ENGINEERING/INSPECTION-ONSITE E/C       399000          0     399000   0.00        0     399000   25      99750     498750

   TOTAL 030     TITLE III DESIGN                399000          0     399000   0.00        0     399000   25      99750     498750

040  PROJECT MANAGEMENT

400000   PROJECT MANAGEMENT                      443000          0     443000   0.00        0     443000   25     110750     553750

   TOTAL 040     PROJECT MANAGEMENT              443000          0     443000   0.00        0     443000   25     110750     553750

700  SPECIAL EQUIP/PROCESS SYSTEMS

210000   PROCUREMENT-ONSITE E/C                 1127452          0    1127452   0.00        0    1127452   30     338236    1465688
310100   AP 102/104 CENTRAL PUMP PIT PREP        225000          0     225000   0.00        0     225000   30      66191     280379
310200   AP 102/104 PULSE AIR SYSTEM             174639          0     174639   0.00        0     174639   30      52391     227030
310300   DECANT PUMP INSTALLATION                321734          0     321734   0.00        0     321734   23      75565     397299
310400   CONTAMINATED EQUIPMENT REMOVAL         3713870          0    3713870   0.00        0    3713870   20     742774    4456644
330000   BURIAL FEE-O/C                          483210          0     483210   0.00        0     483210   30     144963     628173

   TOTAL 700     SPECIAL EQUIP/PROCESS SYSTEM   6045993          0    6045993   0.00        0    6045993   23    1418118    7464111

900  OTHER PROJECT COSTS

500000   OTHER PROJECT COSTS                    3679000          0    3679000   0.00        0    3679000   25     919750    4598750

   TOTAL 900     OTHER PROJECT COSTS            3679000          0    3679000   0.00        0    3679000   25     919750    4598750

                                               ==========================================================================================
PROJECT TOTAL                                                    0                              0                   2,781,118
                                             11,497,993              11,497,993   0.00              11,497,993   24              14,279,111
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ICF KAISER HANFORD                         ** ICES - INTERACTIVE ESTIMATING **                  PAGE  5  OF  8
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                 DATE  09/05/96 07:45:51
JOB NO. 24164AC4                                         STUDY                                  BY     J P H
FILE NO. 24164AC4                        RDG_R05 - ESTIMATE SUMMARY BY CSI DIVISION

                                           ESTIMATE    ONSITE       SUB        ESCALATION        SUB      CONTINGENCY       TOTAL
 CSI   DESCRIPTION                         SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL       TOTAL    %     TOTAL       DOLLARS
------ ----------------------------------- ---------- ---------- ---------- ------ --------- ---------- ----- ---------- ----------

CONSTRUCTION

 00   TECHNICAL SERVICES                      5009000          0    5009000   0.00         0    5009000   25    1252250    6261250
 01   GENERAL REQUIREMENTS                    2260247          0    2260247   0.00         0    2260247   20     442482    2702729
 02   SITEWORK                                 595453          0     595453   0.00         0     595453   30     178636     774089
 15   MECHANICAL                              2787670          0    2787670   0.00         0    2787670   25     697557    3485227
 16   ELECTRICAL                               396623          0     396623   0.00         0     396623   21      85445     482068
 19   PROJECT MANAGEMENT                       443000          0     443000   0.00         0     443000   25     110750     553750

   TOTAL CONSTRUCTION                                        0                             0                      2,781,118
                                           11,497,993             11,497,993   0.00            11,497,993   24                14,279,111

                                         ------------------------------------------------------------------------------------------
PROJECT TOTAL                                                0                             0                      2,781,118
                                           11,497,993             11,497,993   0.00            11,497,993   24                14,279,111
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ICF KAISER HANFORD                     ** ICES - INTERACTIVE ESTIMATING **              PAGE  6  OF  6
WESTINGHOUSE HANFORD COMPANY            AP-102 & AP-104 TANK PULSE AIR SYSTEM           DATE  09/06/96 07:49:36
JOB NO. 24161AC4                                      PIVOT                             BY    J P M
FILE NO. 24165AC4                     DOE_RD6 - CONTINGENCY ANALYSIS BASIS SHEET


        REFERENCE:   ESTIMATE BASIS SHEET                                 PAGE  3    OF  9
                     COST CODE ACCOUNT SUMMARY                            PAGE  4/5  OF  9



             THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.2 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"
        DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A  PIVOT      ESTIMATE
        SHOULD HAVE AN OVERALL RANGE OF    20  TO      30% .

        CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE
        LEVEL OF THE DETAILED COST ESTIMATE.

             ENGINEERING  AND MANAGEMENT  DOE COST CODES 020, 030, 040
                          DUE TO THE DEFINITIVE DESIGN AND E/I DURING CONSTRUCTION EFFORTS BEING CALCULATED AS A
             WBS 1.1      PERCENTAGE OF DIRECT CONSTRUCTION AND PROCUREMENT COSTS, AN OVERALL CONTINGENCY OF 25%
             WBS 1.2      HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                          PLANNING/MANLOADING OF THESE EFFORTS.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA
                          TRACKING AVERAGE DEVIATION OF PROJECT MANAGEMENT COSTS VS DIRECT CONSTRUCTION PROCUREMENT COSTS

             WBS 4.1      DUE TO THE PROJECT MANAGEMENT EFFORTS BEING CALCULATED AS PERCENTAGE OF OTHER DIRECT COSTS (SEE
                          THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGE METHODOLOGY), AN OVERALL CONTINGENCY OF 25
                          PERCENT HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                          PLANNING/MANLOADING OF THIS EFFORT.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA COSTS

                                AVERAGE ENGINEERING CONTINGENCY      25%


             CONSTRUCTION
               COST CODE    700      SPECIAL EQUIPMENT PROCESS SYSTEMS
             WBS 2.1
             WBS 3.1                 AN AVERAGE CONTINGENCY OF 23% HAS BEEN INCORPORATED INTO EQUIP/PROCESS SYSTEMS DUE
             WBS 3.3                 TO INCOMPLETE INFORMATION, SCOPE, SPECIFICATIONS AND DRAWINGS AT THIS TIME.
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ICF KAISER HANFORD                            ** ICEST - INTERACTIVE ESTIMATING **              PAGE  7  OF  8
WESTINGHOUSE HANFORD COMPANY                  AP-102 & AP 104 TANK PULSE AIR SYSTEM             DATE  09/04/96 07:47:34
JOB NO. ZS168AC4                                            STUDY                               BY    J P M
FILE NO. [illegible]                         WBS_804 - CONTINGENCY ANALYSIS BASIS SHEET

     OTHER PROJECT COSTS OPC COST CODE 900

          WBS 7.0   DUE TO THE OTHER PROJECT COSTS EFFORTS BEING CALCULATED AS PERCENTAGES OF OTHER DIRECT COSTS
                    (SEE THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGE METHODOLOGY) AN OVERALL CONTINGENCY
                    OF 25% HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
                    PLANNING/MANLOADING OF THESE EFFORTS.  THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA
                    TRACKING AVERAGE DEVIATION OF OTHER PROJECT COSTS VS DIRECT CONSTRUCTION AND PROCUREMENT COSTS.




                              AVERAGE CONSTRUCTION CONTINGENCY     22%

                              AVERAGE PROJECT CONTINGENCY          24%
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ICF KAISER HANFORD                         ** ICES - INTERACTIVE ESTIMATING **                      PAGE  6  OF  6
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                     DATE  09/03/96 07:45:35
JOB NO. 24146AC4                                        STUDY                                       BY    J P M
FILE NO. L4141AC4                        901_R07 - ONSITE INDIRECT COSTS BY WBS

                                             ESTIMATE     CONTRACT ADMINISTRATION      BID PACK        OTHER          TOTAL
WBS    DESCRIPTION                           SUBTOTAL        %         TOTAL            PREP.       INDIRECTS      INDIRECTS
------ ----------------------------------    --------     -----    ---------        ---------      ---------      ---------

111100 DEFINITIVE DESIGN-ONSITE E/C            731040      0.00            0               0              0              0
121000 ENGINEERING/INSPECTION-ONSITE E/C       399040      0.00            0               0              0              0
210000 PROCUREMENT-ONSITE E/C                 1127492      0.00            0               0              0              0
310100 AP 102/104 CENTRAL PUMP PIT PREP        225948      0.00            0               0              0              0
310200 AP 102/104 PULSE AIR SYSTEM             174639      0.00            0               0              0              0
310400 DECANT PUMP INSTALLATION                321734      0.00            0               0              0              0
310600 CONTAMINATED EQUIPMENT REMOVAL         2713870      0.00            0               0              0              0
350000 BURIAL FEE-O/C                          483210      0.00            0               0              0              0
400000 PROJECT MANAGEMENT                      443000      0.00            0               0              0              0
500000 OTHER PROJECT COSTS                    3479040      0.00            0               0              0              0

                                          ---------------------------------------------------------------------------------
PROJECT TOTAL                              11,497,093                                      0                             0
                                                                           0                              0
```

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ICF KAISER HANFORD                           ** JEST - INTERACTIVE ESTIMATING **                    PAGE      1
WESTINGHOUSE HANFORD COMPANY                AP-102 & AP-104 TANK PULSE AIR SYSTEM                   DATE   09/03/96 07:45:59
JOB NO. 24166AC4                                          STUDY                                      BY     J P B
FILE NO. 14161AC4                       RPT_400 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                        COST                                   EQUIP               SUB-    EQUIP-     OH&P       TOTAL
NUMBER         DESCRIPTION                     CODE  QUANTITY  MANHOURS    LABOR      USAGE   MATERIAL CONTRACT    MENT     / G & A    DOLLARS
-------------- ------------------------------- ---- ---------- --------- ---------- -------- --------- -------- --------- --------- ----------

111100         DEFINITIVE DESIGN-ONSITE E/C

111100.00      TECHNICAL SERVICES
111100.0000004 DEFINITIVE DESIGN               020        1 LS         0          0        0         0   31,000         0         0     31,000
                                                    ---------------------------------------------------------------------------------------
    SUBTOTAL   TECHNICAL SERVICES                                      0                   0             31,000                   0
                                                                                  0                  0                   0               31,000
                                                    ---------------------------------------------------------------------------------------
    TOTAL      COST CODE 02000                                         0                   0             31,000                   0
               WBS 111100                                                         0                  0                   0               31,000
               (ESCALATION   0.00% - CONTINGENCY  25.00 %)


                                                    ---------------------------------------------------------------------------------------
  TOTAL WBS 111100 DEFINITIVE DESIGN-ONSITE E/C                        0                   0             31,000                   0
                                                                                  0                  0                   0               31,000
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ICF KAISER HANFORD                                    ** [illegible] - INTERACTIVE ESTIMATING **              PAGE       2
WESTINGHOUSE HANFORD COMPANY                       AP-102 & AP-104 [illegible] AIR SYSTEM                    DATE  [illegible]/96 07:45:3[illegible]
JOB NO. [illegible]                                                [illegible]                               BY    [illegible]
FILE NO. [illegible]                            DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                           COST                                     EQUIP               SUB-     EQUIP-     OVHD      TOTAL
NUMBER          DESCRIPTION                       CODE   QUANTITY  MANHOURS    LABOR      USAGE   MATERIAL  CONTRACT    MENT     / G & A   DOLLARS
-------------- --------------------------------- ---- ---------- -------- --------- -------- --------- --------- --------- --------- ---------

121000          ENGINEERING/INSPECTION-ONSITE C/C

121000.00       TECHNICAL SERVICES
121000.000000   ENGINEERING INSPECTION            030       1 LS         0         0        0         0    399000         0         0    399000
                                                     ----------------------------------------------------------------------------------------
     SUBTOTAL   TECHNICAL SERVICES                                       0                  0             399,000                   0
                                                                                   0                  0                       0            399,000
                                                     ----------------------------------------------------------------------------------------
     TOTAL      COST CODE 03000                                          0                  0             399,000                   0
                WBS 121000                                                         0                  0                       0            399,000
                (ESCALATION   0.00% - CONTINGENCY  25.00 %)

                                                     ----------------------------------------------------------------------------------------
   TOTAL WBS 121000 ENGINEERING/INSPECTION-ONSITE C/C                    0                  0             399,000                   0
                                                                                   0                  0                       0            399,000
```

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ICF KAISER HANFORD                                   ** ICE - INTERACTIVE ESTIMATING **                        PAGE        3
WESTINGHOUSE HANFORD COMPANY                        AW-102 & AP-104 TANK PULSE AIR SYSTEM                      DATE   09/03/96 07:43:59
JOB NO. 14168A64                                                    STUDY                                      BY      J P M
FILE NO. 14168A64                                 DOE_W04 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                          COST                                      EQUIP                SUB-     EQUIP-      OVHD       TOTAL
NUMBER         DESCRIPTION                       CODE  QUANTITY   MANHOURS     LABOR      USAGE   MATERIAL  CONTRACT     MENT     / G & A    DOLLARS
-------------- --------------------------------- ---- ---------- -------- --------- --------- --------- --------- --------- --------- ----------

210000         PROCUREMENT-ONSITE E/C

210000.15      MECHANICAL
210000.1500004 PULSAIR EQUIPMENT  INCLUDING      700        1 EA        0         0         0     60000         0         0         0      60000
               DESIGN ENG, PLC CONTROLLER
               AST ACCUMULATOR, VALVING,
               PLUMBING & SOFTWARE
210000.1500004 PULSAIR SUPPORT EQUIPMENT         700        1 EA        0         0         0     30000         0         0         0      30000
               INCLUDED
               50 HP/210 ACFM COMPRESSOR
               MTD ON PRE-PLUMBED SKID
210000.1500004 DECANT MIXER PUMP                 700        2 EA        0         0         0    800000         0         0         0     800000
                                                           ------------------------------------------------------------------------------------
    SUBTOTAL   MECHANICAL                                                   0                   0                   0                   0
                                                                                      0   890,000                   0                      890,000
               SALES TAX    8.00 %                                                               71200                   0                    71200
               WAREHOUSING  18.68 %                                                             166252                                        166252
                                                           ------------------------------------------------------------------------------------
     TOTAL     COST CODE 70015                                              0                   0                   0                   0
               WBS 210000                                                             0 1,127,452                   0                    1,127,452
               (ESCALATION    0.00% - CONTINGENCY  30.00 %)

                                                           ------------------------------------------------------------------------------------
  TOTAL WBS 210000 PROCUREMENT-ONSITE E/C                                   0                   0                   0                   0
                                                                                      0 1,127,452                   0                    1,127,452
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ICF KAISER HANFORD                          ** TEST - INTERACTIVE ESTIMATING **                  PAGE       1
WESTINGHOUSE HANFORD COMPANY               AP-102 & AP-104 TANK PULSE AIR SYSTEM                 DATE   09/03/96 07:45:58
JOB NO. ER4185AC4                                          STUDY                                 BY     J P M
FILE NO. 1L165AC4                      DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                     CONST.                SUB-    EQUIP-     OH&P      TOTAL
NUMBER          DESCRIPTION                     CODE   QUANTITY  MANHOURS     LABOR      USAGE   MATERIAL  CONTRACT      MENT    / G & A )  DOLLARS
--------------  ------------------------------  ----  ----------  --------  --------  --------  --------  --------  --------  --------  --------

310100          AP 102/104 CENTRAL PUMP PIT PREP

310100.01       GENERAL REQUIREMENTS
310100.0110104  ******************************  700 F         0          0         0         0         0         0         0         0         0
                   GENERAL REQUIREMENTS
                ******************************
310100.0110106  STEP OFF PAD SUPPORT FOR        700 F    536 HR        536     20513         0         0         0         0     10467     30980
                WBS #310100 TOTAL HOURS 3212
                LESS STEP OFF PAD HR 536 =
                2676 RAW HOURS
310100.0110108  2676 HOURS DIV BY 10 MAN        700 F         0          0         0         0         0         0         0         0         0
                CREW = 268 X 2 SUPPORT
                ATTENDANTS  =  536
                                                      ---------------------------------------------------------------------------------------
        SUBTOTAL  GENERAL REQUIREMENTS                (F1SLAB)         536                   0                   0                10,467
                                                                                20,513                  0                   0                30,980
                GENERAL FOREMAN    7.00 %                               37      1435                                                       1435
                HELP (ON MARKUPS ONLY)                                                                                               746       746
                                                      ---------------------------------------------------------------------------------------
        TOTAL   COST CODE 700F1                                        573                   0                   0                11,213
                WBS 310100                                                      21,948                  0                   0                33,161
                (ESCALATION   0.00% - CONTINGENCY  20.00 %)

310100.01       GENERAL REQUIREMENTS
310100.0113004  ******************************  700 W       0 EA         0         0         0         0         0         0         0         0
                 CHG/RM & DECON STRUCTURE
                ******************************
310100.0113006  ALLOW FOR FRAMING       CARP    700 W    144 HRS       144      6987         0      3000         0         0      3433     13420
                (SIZE OF STRUCTURES UNKNOWN)
                2 EACH CHG/RM AND 2 EACH
                DECON STRUCTURE REQUIRED
310100.0113008  ALLOW FOR UPPER VISQUEEN LAB    700 W    120 HRS       120      4592         0      2000         0         0      2388      8980
                (SIZE OF STRUCTURES UNKNOWN)
310100.0113010  ALLOW FOR ELEC SUPPORT          700 W     80 HRS        80      4211         0         0         0         0      2190      6401
                (SIZE OF STRUCTURES UNKNOWN)
310100.0113012  ALLOW FOR HVAC SUPPORT          700 W     60 HRS        60      2996         0      9000         0         0      1558     13554
                (SIZE OF STRUCTURES UNKNOWN)
                HEPA FILTERS AND FRESH AIR
                MAKE UP
310100.0113102  ALLOW FOR STRUCTURE DECON       700 W    100 HRS       100      3827         0         0         0         0      1990      5817
                (SIZE OF STRUCTURES UNKNOWN)
310100.0113104  ALLOW FOR BURIAL PACKAGING      700 W     40 HRS        40      1531         0      3000         0         0       796      5327
                (SIZE OF STRUCTURES UNKNOWN)
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ICF KAISER HANFORD                 ** IES - INTERACTIVE ESTIMATING **               PAGE      5
WESTINGHOUSE HANFORD COMPANY       AP-102 & AP-104 TANK PULSE AIR STATION            DATE   09/03/96 07:45:59
JOB NO. 24145AC4                                 SIMPT                              BY     J F M
FILE NO. 24145AC4              RPT_080 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                       COST                                     EQUIP             SUB-     EQUIP-     OH&P      TOTAL
NUMBER         DESCRIPTION                    CODE  QUANTITY  MANHOURS   LABOR   USAGE   MATERIAL CONTRACT    MENT   / G & A   DOLLARS
-------------- ------------------------------ ---- ---------- -------- -------- ------- -------- -------- -------- -------- ---------

               INCL 2 EA (4X8) WOOD BOXES
                                              ---------------------------------------------------------------------------------------
     SUBTOTAL  GENERAL REQUIREMENTS           (SUP)                560                0                 0                 12,535
                                                                         24,144             17,000                 0                 53,679
               SUP   40.00%                                        224     9657                                                      9657
               GENERAL FOREMAN    7.00 %                            51     2346                                                      2346
               CONSUMABLES    6.00 %                                                          1020                                   1020
               SALES TAX    8.00 %                                                            1442                 0                 1442
               WAREHOUSING   28.00 %                                                          5045                                   5045
               OH&P (ON MARKUPS ONLY)                                                                                      4252      4252
                                              ---------------------------------------------------------------------------------------
     TOTAL     COST CODE 70001                                     836                0                 0                 16,787
               WBS 310100                                                36,147             24,507                 0                 77,441
               (ESCALATION    0.00% - CONTINGENCY  30.00 %)

310100.02      SITEWORK
310100.0210004 ****************************** 700 W          0         0        0       0        0        0        0        0         0
                   102/104 COVER BLOCKS
               ******************************
310100.0210006 CLEAN WATER PROOFING SEAL'T    700 W      80 HR        80     3062       0        0        0        0     1592      4654
               FROM C/BLK SEAMS (BOTH TANKS)
310100.0210008 PKG BEAM MATERIAL IN BURIAL    700 W       2 HR         2       77       0      110        0        0       40       227
               DRUM  ALLOW FOR ONE EACH
               55 GAL DRUM (BOTH TANKS)
310100.0210010 PREP COVER BLOCK LAY DOWN      700 W       4 HR         4      153       0       50        0        0       80       283
               AREA (TEMPORARY) ONE AREA
               BOTH TANKS
310100.0210012 REMOVE COVER BLOCKS            700 W      16 HR        16      612       0        0        0        0      318       930
310100.0210014 OPERATOR SUPPORT               700 W       8 HR         8      354       0        0        0        0      184       538
310100.0210016 TEAMSTER SUPPORT               700 W       8 HR         8      353       0        0        0        0      184       537
310100.0210017 PACKAGE MISC. FOR BURIAL       700 W       1 JOB        8      353       0        0        0        0      184       537
310100.0210112 REPLACE COVER BLOCKS           700 W      16 HR        16      612       0        0        0        0      318       930
310100.0210114 OPERATOR SUPPORT               700 W       8 HR         8      354       0        0        0        0      184       538
310100.0210116 TEAMSTER SUPPORT               700 W       8 HR         8      353       0        0        0        0      184       537
310100.0210118 SEAL COVER BLOCK SEAMS         700 W      40 HR        40     1531       0      100        0        0      796      2427
               (2 EACH PITS)
310100.0232004 ****************************** 700 W          0         0        0       0        0        0        0        0         0
                 AP 102/104 PUMP PIT EXCAV
                 10 X 10 X 6   (2 EA PITS)
               ******************************
310100.0232005 VACUUM EXCAVATOR (GUZZLER)     700 W      48 HR        48     2121    1091        0        0        0     1103      4315
310100.0232006 GRADE TO 4' DEEP 10X10X6       700 W      36 CY       154     5741       0        0        0        0     2985      8726
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ICF KAISER HANFORD                        ** PCES - INTERACTIVE ESTIMATING **                         PAGE        6
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                       DATE   09/03/96 07:45:39
JOB NO. 2496NAC4                                          PIVOT                                       BY      J P M
FILE NO. 2436JAC4                      REP_F06 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                        COST                                  EQUIP                 SUB-      EQUIP-      OHEP      TOTAL
NUMBER         DESCRIPTION                     CODE  QUANTITY   MANHOURS    LABOR    USAGE    MATERIAL  CONTRACT     RENT     / B E L   DOLLARS
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310100.0232008 4' DEEP TO 8' DEEP TRENCHING    700 W     16 CY       84      3875        0         0         0         0      1929      5804
310100.0232010 OPERATOR SUPPORT                700 W      0 CY        0         0        0         0         0         0         0         0
               (NOT REQUIRED USE GUZZLER)
310100.0232012 LABORER SUPPORT                 700 W      0           0         0        0         0         0         0         0         0
               (NOT REQUIRED USE GUZZLER)
310100.0232016 CONFINED SPACE ATTN'DT          700 W     16 HR       16       612        0         0         0         0       316       928
310100.0232018 SHORING INCL REMOVAL            700 W    600 SF       96      3676        0      1200         0         0      1910      6786
310100.0232032 PLACE B'FILL  (INCLUDES         700 W     66 CY      150      5261        0         0         0         0      2766      8027
310100.0232036 ALLOW FOR FINE GRADE AND        700 W      4 CY       32      1414        0        60         0         0       735      2209
               STABILIZE
310100.0232100 ******************************  700 W      0           0         0        0         0         0         0         0         0
                 AP 102/104  TRENCH EXCAV
               FOR PULSAIR PIPE (2 EA PITS)
               ******************************
310100.0232103 VACUUM EXCAVATOR (GUZZLER)      700 W     48 HR       48      2121     1091         0         0         0      1103      4315
310100.0232106 TRENCH 4 X 5 X 50     NEAT      700 W     44 CY      220      8419        0         0         0         0      4378     12797
               NO SHORE NO ANGLE OF REPOSE
310100.0232132 PLACE B'FILL                    700 W     44 CY      152      5052        0         0         0         0      2437      7489
310100.0232136 ALLOW FOR FINE GRADE AND        700 W      4 CY       32      1414        0        60         0         0       735      2209
               STABILIZE
                                                    --------------------------------------------------------------   ---------   -------------------
    SUBTOTAL   SITEWORK                            (SWP)                1,206             2,102                   0             25,415
                                                                                47,337             1,560                   0               75,713
               SWP   40.00%                                               482   18934                                                        18934
               GENERAL FOREMAN    7.00 %                                  118    4639                                                         4639
               CONSUMABLES    6.00 %                                                                 94                                         94
               SALES TAX    8.00 %                                                                  153                   0                    153
               WAREHOUSING   28.00 %                                                                408                                        408
               OHEP (ON MARKUPS ONLY)                                                                                               12250     12250
                                                    -------------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70002                                          1,806             2,742                   0             38,677
               WBS 310100                                                       70,910             2,277                   0              112,242
               (ESCALATION    0.00% - CONTINGENCY  30.00 %)


                                                    -------------------------------------------------------------------------------------------------
  TOTAL WBS 310100 AP 102/104 CENTRAL PUMP PIT PREP                     3,218             2,142                   0             67,093
                                                                               129,027            34,786                   0              225,887
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ICF KAISER HANFORD                     ** ICES - INTERACTIVE ESTIMATING **                              PAGE        7
WESTINGHOUSE HANFORD COMPANY          AP-102 & AP-104 TANK PULSE AIR SYSTEM                             DATE   09/05/96 07:45:50
JOB NO. 24168AC4                                       STUDY                                            BY     J P M
FILE NO. 24168AC4                   DOE_HQ - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                        COST                                     EQUIP                SUB-     EQUIP-      OH&P        TOTAL
NUMBER         DESCRIPTION                     CODE   QUANTITY  MANHOURS    LABOR      USAGE   MATERIAL  CONTRACT     MENT     / G & A     DOLLARS
-------------- ------------------------------ ----- ---------- -------- -------- -------- -------- -------- -------- -------- ----------

310200         AP 102/104 PULSE AIR SYSTEM

310200.01      GENERAL REQUIREMENTS
310200.01010106 ******************************  760 F        0          0        0        0        0        0        0        0          0
                  GENERAL REQUIREMENTS
               ******************************
310200.01010108 STEP OFF PAD SUPPORT FOR       760 F     142 MH      142     5454        0        0        0        0     2826       8280
               WBS 0310200 TOTAL HOURS 1330
               LESS STEP OFF PAD WE 142
               FIELD ADJ HOURS 471 = 716
310200.01010110 716 HOURS DIV BY 10 MAN        760 F        0          0        0        0        0        0        0        0          0
               CREW = 71 X 2 SUPPORT
               ATTACHMENTS  =  142
                                                    ------------------------------------------------------------------------------------
    SUBTOTAL   GENERAL REQUIREMENTS                 (FIELD)           142               0                 0                 2,826
                                                                              5,454               0                 0                  8,280
               GENERAL FOREMAN    7.00 %                                9      380                                                     380
               OH&P (ON MARKUPS ONLY)                                                                                       197        197
                                                    ------------------------------------------------------------------------------------
    TOTAL      COST CODE 760F1                                        151               0                 0                 3,023
               WBS 310200                                                     5,834               0                 0                  8,857
               (ESCALATION    0.00% - CONTINGENCY  30.00 %)

310200.15      MECHANICAL
310200.1526004 ******************************  760 F        2 EA        0        0        0        0        0        0        0          0
                AP 102/104    FIELD FAB 2"
               RISER W/ 36" AIR DISTRIBUTOR
               ******************************
310200.1526008 FABRICATE SHIELD PLUG           760 F        2 EA      170     9078        0     1000        0        0     4721      14799
               ABSTRACTED FROM ACTUAL ICFKH
               COSTS FOR U-151 PROJECT
               (LABOR & MAT'L $15,000.00)
310200.1524008 42" C/S S.O. FLANGE             760 F        2 EA       16      854        0     3400        0        0      444       4698
310200.1524010 DRILL 2-1/2"DIA. HOLE IN 42"    760 F        2 JOB      32     1709        0        0        0        0      889       2598
               C/S FLANGE
310200.1524012 42" RNG GSKT   (BOLT-UP)        760 F        2 SET      36     1922        0      700        0        0      999       3621
310200.1526016 2" WN SST 150# FLANGE           760 F        8 EA        6      320        0     1170        0        0      166       1656
310200.1524020 2"  SCH 40 SST PIPE             760 F      100 LF       19     1015        0     4000        0        0      528       5543
310200.1524026 2"  SST FIELD WELDS             760 F       16 EA       88     4699        0        0        0        0     2443       7142
310200.1524077 WELD AIR DISTRIBUTOR HEAD       760 F        2 EA       22     1175        0        0        0        0      611       1786
               TO RISER PIPE
310200.1524050 WELD 2" SST RISER TO OPNG       760 F        2 EA        6      320        0        0        0        0      166        486
               IN 42" FLANGE
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ICF KAISER HANFORD                        ** TEST - INTERACTIVE ESTIMATING **                  PAGE       8
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                DATE  07/05/96 07:45:39
ADP NO. E4165AC4                                        STUDY                                  BY     J P M
FILE NO. 24165AC4                  DET_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                       EQUIP                SUB-     EQUIP-      OH&P       TOTAL
NUMBER         DESCRIPTION                      CODE   QUANTITY  MANHOURS     LABOR      USAGE  MATERIAL CONTRACT       MENT   / F E E     DOLLARS
-------------- -------------------------------- ---- ---------- -------- --------- --------- --------- -------- ---------- --------- -----------

310200.1520052 4" O.D X 2.5" I.D. SST INSERT   700 F       2 EA       16       854         0        64        0          0       444        1362
310200.1520054 1/16" X 1/2" SST FLATS          700 F     170 LF       20      1068         0       510        0          0       555        2133
310200.1520056 SPOT WELD SST FLATS TO          700 F     200 LF       24      1282         0         0        0          0       667        1949
               EXTERIOR OF 2" RISER PIPE
310200.1520058 HYDRO TEST RISER                700 F      2 JOB       16       854         0         0        0          0       444        1298
                                                     -------------------------------------------------------------------------------------------
      SUBTOTAL  MECHANICAL                           (FIELD)         471                   0                  0                13,077
                                                                              25,150               10,794                    0                 49,021
                GENERAL FOREMAN   7.00 %                              32      1760                                                              1760
                CONSUMABLES   6.00 %                                                                 647                                         647
                SALES TAX   8.00 %                                                                   915                     0                   915
                WAREHOUSING  28.00 %                                                                3207                                        3207
                OHLP (ON MARKUPS ONLY)                                                                                                915         915
                                                     -------------------------------------------------------------------------------------------
      TOTAL     COST CODE 70015                                      503                   0                  0                13,992
                WBS 310200                                                    26,910               15,563                    0                 56,465
                (ESCALATION   0.00% - CONTINGENCY  30.00 %)

310200.15       MECHANICAL
310200.1524120 ******************************* 700 W          0         0         0         0         0        0          0         0           0
                 AP 102/104 INSTALL PIPING
                  EQUIPMENT   (ON SKP'S)
               *******************************
310200.1524122 PROVIDE AND INSTALL TANK        700 W       2 EA       48      2563         0     30000        0          0      1333       33896
               FARM COMPLEX JUMPER W/CONN.
               HEADS & B/FLOW PREVENTER
               (ALLOWANCE)
310200.1524123 OPERATION SUPPORT TO SET        700 W       2 EA       32      1414         0         0        0          0       735        2149
               JUMPERS
310200.1524127 PLACE COMPRESSOR SKID           700 W       1 EA       24      1282         0         0        0          0       667        1949
310200.1524128 OPERATING SUPPORT               700 W       1 EA       12       641         0         0        0          0       333         974
310200.1524129 FIELD COAT & WRAP SST (PREP     700 W     100 LF       20      1068         0        50        0          0       555        1673
               FOR BURIAL)
310200.1524130 2" SCH 40 SST PIPE              700 W     100 LF       15       801         0      3000        0          0       417        4218
310200.1524132 ALLOWANCE FOR 2" SST FTGS       700 W       2 LS        8       427         0      1000        0          0       222        1649
310200.1524134 ALLOWANCE FOR 2" SST FIELD      700 W       2 LS      160      8544         0         0        0          0      4443       12987
               WELDS
310200.1524136 ALLOWANCE FOR CONNECTION TO     700 W       2 LS       32      1709         0         0        0          0       889        2598
               SKID COMPRESSOR
310200.1524150 ALLOWANCE FOR MECHANICAL AIR    700 W       2 LS       16       854         0         0        0          0       444        1298
310200.1524152 ALOWANCE FOR FIBER GLASS        700 W       1 LS        2       107         0       200        0          0        56         363
               VALVE MANIFOLD BOX
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ICF KAISER HANFORD                              ** TEST - INTERACTIVE ESTIMATING **                          PAGE       9
WESTINGHOUSE HANFORD COMPANY                  AP-102 & AP-104 TANK PULSE AIR SYSTEM                          DATE   09/03/96 07:45:59
JOB NO. 24148AC4                                              STD01                                          BY     J P M
FILE NO. 24148AC4                          DOE_R08 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                        COST                                     EQUIP              SUB-    EQUIP-      OH&P      TOTAL
NUMBER         DESCRIPTION                     CODE  QUANTITY  MANHOURS    LABOR        USAGE  MATERIAL  CONTRACT     MENT   / F E E    DOLLARS
-------------- ------------------------------- ---- ---------- -------- --------- ---------- --------- --------- --------- --------- ----------

310200.1528154 ALLOWANCE FOR VLV CONTROLLER    700 W      1 LS        8       427          0      1000         0         0       222       1649
310200.1528156 ALLOWANCE FOR AIR REGULATORS    700 W      1 LS        8       427          0      1000         0         0       222       1649
                                                  ------------------------------------------------------------------------------------------
    SUBTOTAL   MECHANICAL                         (SWP)             385                    0                   0              10,538
                                                                             20,264                 36,250                 0              67,052
               SWP   40.00%                                         154      8105                                                           8105
               GENERAL FOREMAN   7.00 %                              37      1987                                                           1987
               CONSUMABLES   6.00 %                                                                   2175                                  2175
               SALES TAX   8.00 %                                                                     3074                 0                3074
               WAREHOUSING  28.00 %                                                                  10759                                 10759
               OH&P (ON MARKUPS ONLY)                                                                                               5247    5247
                                                  ------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70015                                      576                    0                   0              15,785
               WBS 310200                                                    30,356                 52,258                 0              98,399
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

310200.16      ELECTRICAL
310200.1600004 ******************************* 700 W      0               0         0          0         0         0         0         0          0
               ELECTRICAL PWR INSTALLATION
               *******************************
310200.1600008 ALLOWANCE FOR ELECTRICAL        700 W      1 JOB       6       421          0       100         0         0       219        740
               PLUG IN ABOVE GROUND LINE
310200.1600009 ALLOWANCE - INSTRUMENTATION     700 W      1 JOB      56      2632          0      2000         0         0      1369       6001
               (FROM JUMPER TO COMPRESSOR)
310200.1600010 ALLOWANCE FOR ELECTRICAL AIR    700 W      1 JOB       6       421          0         0         0         0       219        640
                                                  ------------------------------------------------------------------------------------------
    SUBTOTAL   ELECTRICAL                         (SWP)              68                    0                   0               1,807
                                                                              3,474                  2,100                 0               7,381
               SWP   40.00%                                          26      1389                                                           1389
               GENERAL FOREMAN   7.00 %                               4       340                                                            340
               CONSUMABLES   6.00 %                                                                    126                                   126
               SALES TAX   8.00 %                                                                      178                 0                 178
               WAREHOUSING  28.00 %                                                                    623                                   623
               OH&P (ON MARKUPS ONLY)                                                                                                899       899
                                                  ------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70016                                       98                    0                   0               2,706
               WBS 310200                                                     5,204                  3,027                 0              10,938
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)


                                                  ------------------------------------------------------------------------------------------
   TOTAL WBS 310200 AP 102/104 PULSE AIR SYSTEM                   1,351                    0                   0              55,546
                                                                             40,706                 78,865                 0             174,438
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ICF KAISER HANFORD                                  ** JEST - INTERACTIVE ESTIMATING **                     PAGE      10
WESTINGHOUSE HANFORD COMPANY                        AP-102 & AP-104 TANK PULSE AIR SYSTEM                   DATE   09/03/96 07:45:19
JOB NO. Z4146ACA                                                  STUDY                                     BY     J P M
FILE NO. Z4146ACG                               DOE_R0? - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                         COST                                     EQUIP              SUB-    EQUIP-     ORHP     TOTAL
NUMBER          DESCRIPTION                     CODE  QUANTITY  MANHOURS    LABOR        USAGE   MATERIAL CONTRACT    MENT    / B L F   DOLLARS
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310400          DECANT PUMP INSTALLATION

310400.15       MECHANICAL
310400.1500004  COST DATA OBTAINED FROM          700 F         0          0          0        0        0        0        0        0        0
                PROJECT W-211 ESTIMATED COST
310400.1500006  TRAINING                         700 F   2440 MH       2440     128863        0        0        0        0    67009   195872
                                                      ------------------------------------------------------------------------------------
      SUBTOTAL  MECHANICAL                            (FIELD)         2,440                 0                 0             67,009
                                                                            128,863                 0                 0               195,872
                GENERAL FOREMAN    7.00 %                               171       9020                                                   9020
                ORHP (ON MARKUPS ONLY)                                                                                   4690         4690
                                                      ------------------------------------------------------------------------------------
      TOTAL     COST CODE 70015                                       2,611                 0                 0             71,699
                WBS 310400                                                  137,883                 0                 0               209,582
                (ESCALATION    0.00% - CONTINGENCY  20.00 %)

310400.15       MECHANICAL
310400.1500008  PUMP INSTALLATION                700 M       2 EA       500      23950        0        0        0        0    12454    36404
                                                      ------------------------------------------------------------------------------------
      SUBTOTAL  MECHANICAL                            (MARK)            500                 0                 0             12,454
                                                                             23,950                 0                 0                36,404
                SWP  100.00%                                            500      23950                                                  23950
                GENERAL FOREMAN    7.00 %                                70       3353                                                   3353
                ORHP (ON MARKUPS ONLY)                                                                                  14197        14197
                                                      ------------------------------------------------------------------------------------
      TOTAL     COST CODE 70015                                       1,070                 0                 0             26,651
                WBS 310400                                                   51,253                 0                 0                77,904
                (ESCALATION    0.00% - CONTINGENCY  30.00 %)

310400.16       ELECTRICAL
310400.1600000  ALLOW FOR ELEC. CONNECTION       700 M       2 EA       200      10528        0        0        0        0     5475    16003
                                                      ------------------------------------------------------------------------------------
      SUBTOTAL  ELECTRICAL                            (MARK)            200                 0                 0              5,475
                                                                             10,528                 0                 0                16,003
                SWP  100.00%                                            200      10528                                                  10528
                GENERAL FOREMAN    7.00 %                                28       1472                                                   1472
                ORHP (ON MARKUPS ONLY)                                                                                   8240         8240
                                                      ------------------------------------------------------------------------------------
      TOTAL     COST CODE 70016                                         428                 0                 0             13,715
                WBS 310400                                                   22,528                 0                 0                36,243
                (ESCALATION    0.00% - CONTINGENCY  30.00 %)
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ICF KAISER HANFORD                        ** ICES - INTERACTIVE ESTIMATING **                      PAGE      11
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                    DATE  09/03/96 07:45:40
JOB NO. 24106AC4                                        STUDY                                       BY      J P M
FILE NO. 24106AC4                    DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                            COST                                 EQUIP                SUB-      EQUIP-      OVEP        TOTAL
NUMBER          DESCRIPTION                        CODE  QUANTITY  MANHOURS    LABOR    USAGE   MATERIAL  CONTRACT     MENT      / O & I     DOLLARS
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  TOTAL WBS 318400 DECANT PUMP INSTALLATION                          4,117                 0                   0                  110,087
                                                                          211,648                  0                    0                321,735
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ICF KAISER HANFORD                          ** TEST - INTERACTIVE ESTIMATING **                  PAGE      12
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                  DATE  09/03/96 07:45:40
JOB NO. 26161AC6                                          STUDY                                  BY     J T M
FILE NO. 26161AC6                   ORE_EWB - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                       COST                                        EQUIP                SUB-     EQUIP-      OVER       TOTAL
NUMBER         DESCRIPTION                    CODE   QUANTITY  MANHOURS     LABOR    USAGE  MATERIAL   CONTRACT     MENT     J O L I    DOLLARS
-------------- ------------------------------ ---- ---------- --------- --------- -------- --------- ---------- -------- ---------- ----------

310600         CONTAMINATED EQUIPMENT REMOVAL

310600.01      GENERAL REQUIREMENTS
310600.0123610 ****************************** 700 W        0          0         0        0         0          0        0          0          0
                   GREENHOUSE SUPPORT
               ******************************
310600.0123620 ERECT/DISMANTLE GREENHOUSE     700 W      6 EA         0         0        0         0          0        0          0          0
               AT THE FOLLOWING:
               PUMPS (3), SLURRY DIST. (1)
               AND TEMP TIEIN  (2)
310600.0123622 CARPENTERS     (FRAMING)       700 W      6 EA       624     27250        0     15000          0        0      15170      57420
310600.0123624 LABORERS       (VISQUEEN)      700 W      6 EA       624     23000        0      9000          0        0      12438      44438
310600.0123626 PACKAGE VISQUEEN FOR BURIAL    700 W      6 EA       192      7348        0         0          0        0       3821      11169
310600.0123628 STEP-OFF PAD FOR TANKS (2)     700 W     2 JOB     14704    563704        0         0          0        0     274208     837912
               ASSUME 2 LABORERS FOR
               DURATION OF CONSTRUCTION
               (21 MONTHS)
310600.0136120 INSTALL SHIELDING AT PUMP      700 W     2 JOB       320     12244        0    200000          0        0       6368     218612
               PIT AND RISERS TO LOWER
               EXPOSURE TO CONSTRUCTION
               CRAFT
310600.0136122 ALLOWANCE TO HANDLE AND LOAD   700 W     10 EA       160      6123        0    200000          0        0       3184     209307
               BURIAL BOXES WITH LOW LEVEL
               WASTE GENERATED DURING TANK
               FARM CONSTRUCTION
310600.0136124 ALLOWANCE FOR REMOTE TOOLS     700 W      1 LS         0         0        0     50000          0        0          0      50000
                                                   ----------------------------------------------------------------------------------------
      SUBTOTAL GENERAL REQUIREMENTS                (SWP)         16,604                   0                      0               334,149
                                                                          642,451              474,000                   0                1,450,600
               SWP     40.00%                                      6683    257032                                                            257032
               GENERAL FOREMAN    7.00 %                           7034     62977                                                             62977
               CONSUMABLES    6.00 %                                                        28440                                             28440
               SALES TAX    8.00 %                                                          40195                    0                        40195
               WAREHOUSING   28.00 %                                                       140683                                            140683
               OVHP (ON MANHRS ONLY)                                                                                              164419     164419
                                                   ----------------------------------------------------------------------------------------
      TOTAL    COST CODE 70001                                   29,022                   0                      0               540,586
               WBS 310600                                                 962,461              683,318                   0                2,144,564
               (ESCALATION    0.00% - CONTINGENCY  20.00 %)

310600.15      MECHANICAL
310600.1526106 ****************************** 700 W        0          0         0        0         0          0        0          0          0
                   MIXER PUMP AND SLURRY
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ICF KAISER HANFORD                          ** ICES - INTERACTIVE ESTIMATING **                PAGE      13
WESTINGHOUSE HANFORD COMPANY               AP-102 & AP-104 TANK PULSE AIR MIXER                DATE   09/05/96 07:45:40
JOB NO. [illegible]                                        FINAL                               BY     J P M
FILE NO. [illegible]                   R01_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                      COST                                   EQUIP               SUB-    EQUIP-     OH&P      TOTAL
NUMBER         DESCRIPTION                   CODE  QUANTITY  MANHOURS     LABOR     USAGE  MATERIAL  CONTRACT     MENT   ( G & A )  DOLLARS
-------------- ----------------------------- ---- ---------- -------- --------- -------- --------- -------- -------- --------- ---------

               DISTRIBUTOR BURIAL CONTAINER
               ****************************
310600.1526106 3'X 60' MIXER PUMP CONTAINER  700 F      1 EA        0         0        0     55000        0        0         0     55000
310600.1526108 3'X 60' SLURRY CONTAINTER     700 F      1 EA        0         0        0     55000        0        0         0     55000
310600.1526110 3'X 60' THREE PUMP CONTAINER  700 F      2 EA        0         0        0    110000        0        0         0    110000
310600.1526111 3'X 60' THERM'CPLE CONTAINER  700 F      2 EA        0         0        0    110000        0        0         0    110000
310600.1526112 ****************************  700 F      0           0         0        0         0        0        0         0         0
                          TRAINING
               MXR/PMP & SLR' DIST REMOVAL
               ****************************
310600.1526114 CONSTRUCTION PERSONNEL AT     700 F     20 EA     2000    128160        0         0        0        0     66643    194803
               COLD TEST FACILITY FOR 2
               WEEK TRAINING
310600.1526116 CONSTRUCTION PERSONNEL AT     700 F     10 EA      400     21360        0         0        0        0     11107     32467
               TANK FARM FOR 1 WEEK FOR
               PREPARATION
                                                  ------------------------------------------------------------------------------------
     SUBTOTAL  MECHANICAL                         (FIELD)       2,400                 0                  0                 77,750
                                                                        149,520             330,000                 0               557,270
               GENERAL FOREMAN    7.00 %                          196     10466                                                     10466
               CONSUMABLES    6.00 %                                                          19800                                 19800
               SALES TAX    8.00 %                                                            27984                 0               27984
               WAREHOUSING   28.00 %                                                          97944                                 97944
               OH&P FOR MARKUPS ONLY                                                                                        5442     5442
                                                  ------------------------------------------------------------------------------------
     TOTAL     COST CODE 700F5                                  2,596                 0                  0                 83,192
               WBS 310600                                               159,986             475,728                 0               718,906
               (ESCALATION   0.00% - CONTINGENCY  20.00 %)

310400.F3      MECHANICAL
310400.1526104 ****************************  700 M      2 EA        0         0        0         0        0        0         0         0
                REMOVE FAILED MIXER PUMP
                 2 EACH TRANSFER PUMPS AND
                  SLURRY DISTRIBUTORS
310400.1526106 ****************************  700 M      0           0         0        0         0        0        0         0         0
310400.1526110 COST DATA OBTAINED FROM       700 M      0           0         0        0         0        0        0         0         0
               PROJECT W-211 ESTIMATED COST
310400.1526120 *  MIXER PUMP & SLURRY DIST*  700 M      0           0         0        0         0        0        0         0         0
               REMOVAL: PMP MOTOR, INSTALL
               FLEX RECIEVER, REMOVE MIXER
               **** PUMP & SLURRY DIST. ***
310400.1526122 RIGGER             (4 EACH)   700 M      4 EA     1120     57600        0         0        0        0     31104     88704
```

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ICF KAISER HANFORD                                 ** ICE - INTERACTIVE ESTIMATING **                        PAGE      16
WESTINGHOUSE HANFORD COMPANY                      AP-102 & AP-104 TANK PULSE AIR SYSTEM                      DATE   07/05/96 07:45:40
JOB NO. 24145A04                                               STUDY                                         BY      J P M
FILE NO. 24145A04                             WBS_ROB - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                          COST                                      EQUIP               SUB-     EQUIP-     OHCP       TOTAL
NUMBER          DESCRIPTION                      CODE   QUANTITY   MANHOURS     LABOR     USAGE   MATERIAL  CONTRACT     MENT    / W & I    DOLLARS
--------------- -------------------------------- ---- ----------- --------- ---------- -------- ---------- --------- -------- --------- ----------

310600.1526124 ELECTRICIAN        (5 EACH)      700 M      4 EA        480      25267        0          0         0        0     13139      38406
310600.1526126 IRONWORKER         (2 EACH)      700 M      4 EA        320      15536        0          0         0        0      8079      23615
310600.1526128 P C                (1 EACH)      700 M      4 EA        160       8026        0          0         0        0      4174      12200
310600.1526130 LABORERS           (5 EACH)      700 M      4 EA        800      30616        0          0         0        0     15920      46536
310600.1526132 OPERATOR/ OILER    (1 EACH)      700 M      4 EA        320      14141        0          0         0        0      7353      21494
310600.1526134 HPT                (1 EACH)      700 M      4 EA          0          0        0          0         0        0         0          0
               FURNISHED BY WHC
                                                ----------------------------------------------------------------------------------------------
    SUBTOTAL   MECHANICAL                       (MASK)                 3,200                 0                    0               79,745
                                                                                 153,394                 0                    0             233,139
               SWP   100.00%                                            3200     153394                                                     153394
               GENERAL FOREMAN    7.00 %                                 448      21475                                                      21475
               OHCP (ON MARKUPS ONLY)                                                                                          40951      40951
                                                ----------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70415                                          6,848                 0                    0              120,696
               WBS 310600                                                        328,263                 0                    0             448,960
               (ESCALATION   0.00% - CONTINGENCY  20.00 %)

310600.16      ELECTRICAL
310600.1600010 ALLOWANCE: THERMOCOUPLE          700 M     740 MH        740      38934        0      45000         0        0     20276     104210
               REPLACEMENT
310600.1600012 ALLOWANCE: CEMS                  700 M      80 MH         80       4211        0     100000         0        0      2190     106401
                                                ----------------------------------------------------------------------------------------------
    SUBTOTAL   ELECTRICAL                       (MASK)                   820                 0                    0               22,466
                                                                                  43,145            145,000                    0             210,611
               SWP   100.00%                                             820      43145                                                      43145
               GENERAL FOREMAN    7.00 %                                 115       6040                                                       6040
               CONSUMABLES    6.00 %                                                                8700                                      8700
               SALES TAX    8.00 %                                                                 12296                    0                12296
               WAREHOUSING   28.00 %                                                               43036                                     43036
               OHCP (ON MARKUPS ONLY)                                                                                          25570      25570
                                                ----------------------------------------------------------------------------------------------
    TOTAL      COST CODE 70416                                          1,755                 0                    0               48,036
               WBS 310600                                                         92,375            209,032                    0             349,443
               (ESCALATION   0.00% - CONTINGENCY  20.00 %)

                                                ----------------------------------------------------------------------------------------------
  TOTAL WBS 310600 CONTAMINATED EQUIPMENT REMOVAL                      36,621                 0                    0              802,500
                                                                               1,545,203          1,366,078                    0           3,713,076
```

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ICF KAISER HANFORD                         ** ICES - INTERACTIVE ESTIMATING **                       PAGE     15
WESTINGHOUSE HANFORD COMPANY              AP-102 & AP-104 TANK PULSE AIR SYSTEM                      DATE  09/05/96 07:45:40
JOB NO. 24103AE6                                          STUDY                                      BY    J F M
FILE NO. L6166AC4                       WBS_700 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                       COST                                    EQUIP                 SUB-     CONTIN-     ONSP       TOTAL
NUMBER         DESCRIPTION                    CODE   QUANTITY   MANHOURS    LABOR     USAGE   MATERIAL   CONTRACT    GENCY     / B E I    DOLLARS
-------------- ------------------------------ ---- ---------- -------- -------- -------- -------- -------- -------- -------- ---------

330000         BURIAL FEE-O/C

330000.02      SITEWORK
330000.0270004 4 X 4 X 8 BURIAL BOX (2 EA)    700     256 CF         0        0        0        0     4572        0        0      4572
               ANN/HTR & DECON STRUCTURES
330000.0270006 55 GAL. DRUM COVER BLOCK       700       7 CF         0        0        0        0      125        0        0       125
               BEAM MATERIAL , 1 EACH
330000.0270008 55 GAL. DRUM COVER BLOCK       700      14 CF         0        0        0        0      250        0        0       250
               LAY DOWN AREA VIEWBEER
               2 EACH
330000.0270016 3'DIA X 60' BURIAL CONTR'R     700    2544 CF         0        0        0        0   429940        0        0    429940
               MIXER,TRANSFER PUMPS SLURRY
               DIST & TEMP/LEVEL (INCLUDED
               ARE 4 EACH CONTAINERS)
700000.0270010 3' DIA X 60' LONG BURIAL       700     424 CF         0        0        0        0    48323        0        0     48323
               CONTAINER FOR SLURRY DIST
                                                    ------------------------------------------------------------------------------------
     SUBTOTAL  SITEWORK                                              0                 0           483,210                 0
                                                                              0                 0                 0                483,210
                                                    ------------------------------------------------------------------------------------
     TOTAL     COST CODE 700?                                        0                 0           483,210                 0
               WBS 330000                                                     0                 0                 0                483,210
               (ESCALATION   0.00% - CONTINGENCY  30.00 %)

                                                    ------------------------------------------------------------------------------------
   TOTAL WBS 330000 BURIAL FEE-O/C                                   0                 0           483,210                 0
                                                                              0                 0                 0                483,210
```

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ICF KAISER HANFORD                      ** ICE - INTERACTIVE ESTIMATING **                       PAGE      16
WESTINGHOUSE HANFORD COMPANY           AP-102 & AP-104 TANK PULSE AIR SYSTEM                    DATE  08/03/96 07:45:40
JOB NO. 24168AC4                                       STUDY                                    BY     J P W
FILE NO. 24165AC4                    SOL_R08 - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                     COST                                  EQUIP               SUB-     EQUIP-     OVER      TOTAL
NUMBER        DESCRIPTION                   CODE   QUANTITY  MANHOURS    LABOR    USAGE   MATERIAL  CONTRACT    MENT     / G & A   DOLLARS
------------- ----------------------------- ---- ---------- --------- --------- -------- --------- --------- --------- --------- ---------

400000        PROJECT MANAGEMENT

400000.10     PROJECT MANAGEMENT
400000.100000 PROJECT MANAGEMENT            040        1 LS         0         0        0         0    443000         0         0    443000
                                                 -------------------------------------------------------------------------------------
     SUBTOTAL PROJECT MANAGEMENT                                    0                  0               443,000                   0
                                                                              0                  0                     0               443,000
                                                 -------------------------------------------------------------------------------------
     TOTAL    COST CODE 44417                                       0                  0               443,000                   0
              WBS 400000                                                      0                  0                     0               443,000
              (ESCALATION   0.00% - CONTINGENCY  25.00 %)

                                                 -------------------------------------------------------------------------------------
  TOTAL WBS 400000 PROJECT MANAGEMENT                               0                  0               443,000                   0
                                                                              0                  0                     0               443,000
```

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ICF KAISER HANFORD                        ** ICE - INTERACTIVE ESTIMATING **                  PAGE      17
WESTINGHOUSE HANFORD COMPANY               AP-102 & AP-104 TANK PULSE AIR SYSTEM               DATE  09/01/94 07:45:40
JOB NO. Z4145164                                        STUDY                                  BY     J F N
FILE NO. Z4145AC4                      DOE_WBS - ESTIMATE DETAIL BY WBS / COST CODE

ACCOUNT                                       COST                                       EQUIP                         SUB-     EQUIP-      OTHER       TOTAL
NUMBER          DESCRIPTION                   CODE  QUANTITY  MANHOURS     LABOR     USAGE  MATERIAL  CONTRACT     MENT      / M & I    DOLLARS
--------------- ----------------------------- ---- ---------- -------- --------- -------- --------- --------- --------- --------- ---------

500000          OTHER PROJECT COSTS

500000.00       TECHNICAL SERVICES
500000.000016   PERMITTING & SAFETY           900        1 LS        0         0        0         0     88000         0         0     88000
                BASED ON 2% OF DIRECT
                CONSTRUCTION LESS BURIAL
500000.000017   OPC ACTIVITIES                900        1 LS        0         0        0         0   3370000         0         0   3370000
                BASED ON 76% OF DIRECT
                CONSTRUCTION LESS BURIAL
500000.000018   WHC SUPPORT                   900        1 LS        0         0        0         0    221000         0         0    221000
                BASED ON  5% OF DIRECT
                CONSTRUCTION LESS BURIAL
                                                   ----------------------------------------------------------------------------------------
      SUBTOTAL  TECHNICAL SERVICES                                    0                  0           3,679,000                     0
                                                                                0                  0                     0             3,679,000
                                                   ----------------------------------------------------------------------------------------
      TOTAL     COST CODE 900                                         0                  0           3,679,000                     0
                WBS 500000                                                      0                  0                     0             3,679,000
                (ESCALATION   0.00% - CONTINGENCY  25.00 %)

                                                   ----------------------------------------------------------------------------------------
  TOTAL WBS 500000 OTHER PROJECT COSTS                                0                  0           3,679,000                     0
                                                                                0                  0                     0             3,679,000
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ICF KAISER HANFORD                           ** BEST - INTERACTIVE ESTIMATING **                         PAGE     18
WESTINGHOUSE HANFORD COMPANY                AP-102 & AP-104 TANK PULSE AIR SYSTEM                        DATE  09/03/94 07:45:50
JOB NO. ES1658AC4                                          STUDY                                         BY    J P W
FILE NO. ES1658AC4                      POL_R09 - ESTIMATE DETAIL OF WBS / COST CODE

ACCOUNT                                         COST                                    EQUIP                 SUB-     EQUIP-      OH&P       TOTAL
NUMBER           DESCRIPTION                    CODE  QUANTITY  MANHOURS      LABOR     USAGE    MATERIAL  CONTRACT     RENT     / B & I    DOLLARS
--------------- ------------------------------- ---- ---------- -------- ---------- -------- ---------- ---------- ---------- ---------- ----------


REPORT TOTAL                                                      53,287               2,182            5,935,210             3,015,177
                                                                              1,932,282           2,393,181                       0            14,497,992
```

APPENDIX B

SAMPLING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

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APPENDIX B

SAMPLING SYSTEM ALTERNATIVE GENERATION AND ANALYSIS

B1.0 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 (Galbraith et al 1996a)

Section B1 0 includes a description of the options evaluated and discusses the comparison of the options to the decision criteria Section B2 0 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

B1.1 STATEMENT OF THE PROBLEM

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

B1.2 DECISION ISSUES

B1.2.1 Open Issues

The variability in supernatant composition from riser to riser 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 limits, 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.

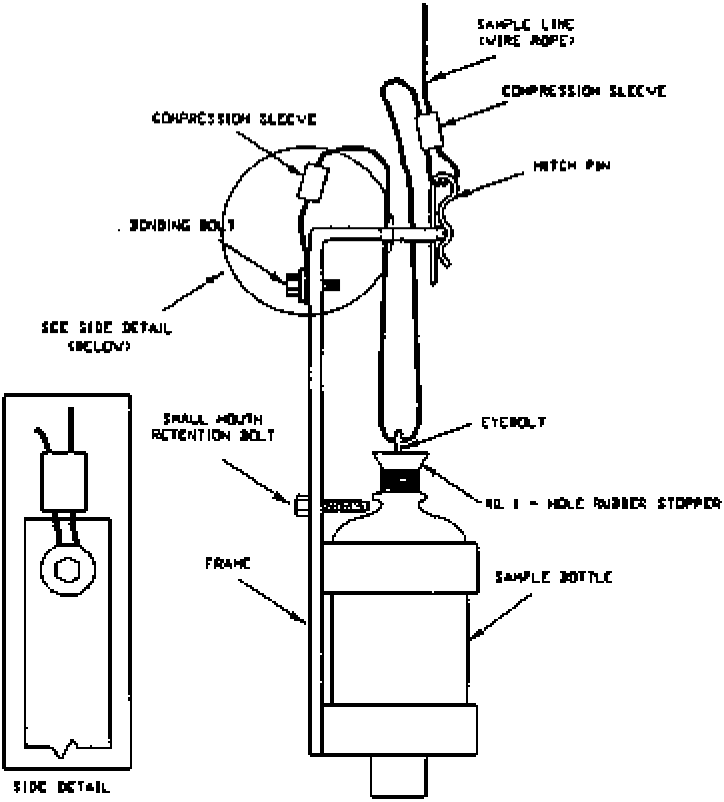
B1.3 DESCRIPTION OF OPTIONS CONSIDERED

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 for the "not-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 1 - Grab Sampler or "Bottle-on-a-String"

The current method of sampling supernatant in the DSTs is the grab sampler or "Bottle-on-a-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 in.) 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.

Figure B1-1. Grab Sample Bottle Assembly.



To obtain the sample, the cover is removed from the riser The sample bottle in the sampler carrier 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 disposed of appropriately After surveying the sample to determine extremity 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 and rinsed with warm water to remove as much contamination as possible The sample bottle is then transferred into a plastic bag and placed in the sample pig After putting the lid on the pig and installing the locking pin, the dose rate is checked to ensure administrative control limits associated with handling and transporting the pig are not exceeded The riser cover is then reinstalled on the riser and appropriate housekeeping completed restoring the tank farm to normal operational condition

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

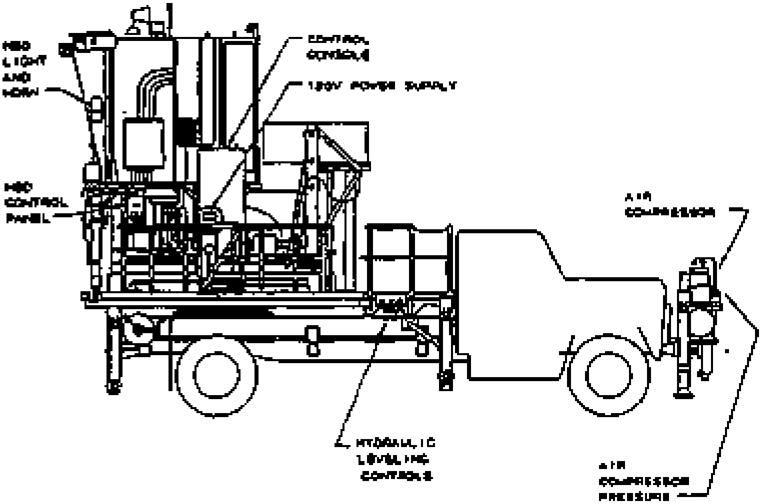
- Material collected in the bottle may be contaminated by material from adjacent elevations due to the movement of the sampler when the stopper or cork is removed
- Samples collected are not currently temperature controlled (except freeze protection) after removal from the tank

B1.3.2 Option 2 - Core 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 skid 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 in) of the bottom of the tank The core sampling truck 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 truck 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 attached until the sampler is just above the waste surface The drill string is pushed into the waste to obtain the sample

Figure B1-2. Core Sampling Truck.



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 an 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 shielded hot cell in the sampling facility. A piping plan showing the location of the sampling facility is shown in Figure B1-3.

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

B1.4 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 sampling options. The criteria to be used are described in the following sections.

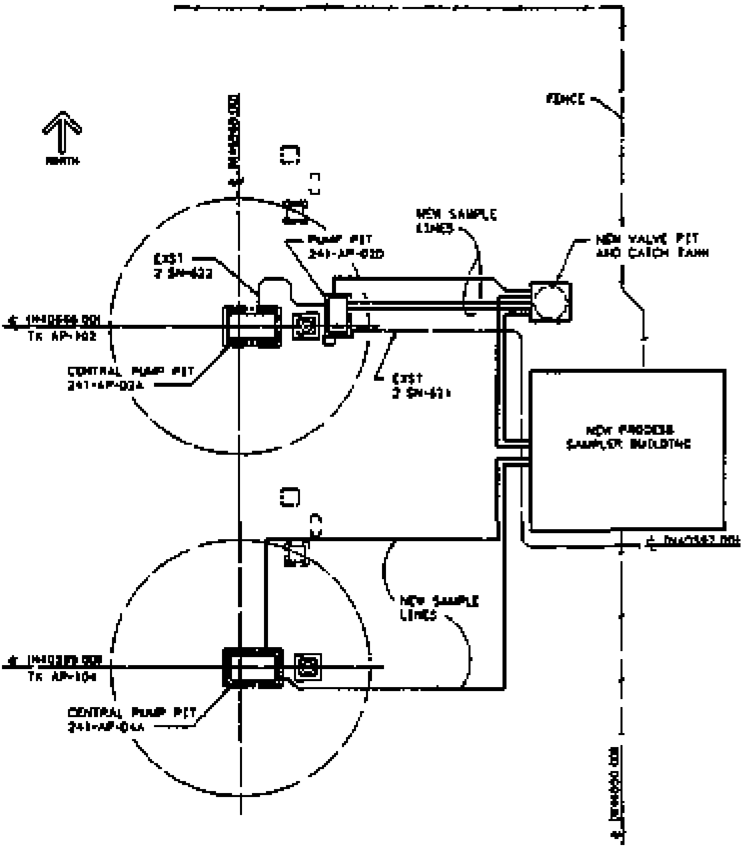
B1.4.1 Cost

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 I 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 reparability 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. Reparability 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 if 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 meets 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 (Spohr 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.

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

Decision criteria	Option		
	Option 1 "Grab Sampler"	Option 2 "Core Sampler"	Option 3 "Isolok Sampler"
Cost[a] "Well-mixed" ("Not-mixed")	$3,860,000 ($9,840,000)	$12,670,000 ($18,540,000) Note: $5.75M of this is for a new core sampling truck/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 milestones. 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 major impact on the project milestones. The fabrication, procurement, testing, 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

Decision criteria	Option		
	Option 1 "Grab Sampler"	Option 2 "Core Sampler"	Option 3 "Isolok Sampler"
Maintainability	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
Technical maturity	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 criteria established and substantially reduces the radiation exposure. In addition, factors due to weather conditions are eliminated.

[a] 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 AGA 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 DOE'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 Ventilation System - Pressure* The sampling 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 sampling 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)

- *Shielding Criteria* 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

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 specifications that set forth engineering requirements deemed 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 Piping*

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 hot 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* (Spohr 1995) for the grab and push mode sampling.

- The exposure detriment for the grab sampler is based on a total person-rem 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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B4.0 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.

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 criteria of schedule. Option 3, the Isolok 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 criterion. 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.

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

Costs	Option 1 "Grab Sampler"		Option 2 "Core Sampler"		Option 3 "Isolok Sampler"	
	Well-mixed[a]	Not-mixed[b]	Well-mixed[a]	Not-mixed[b]	Well-mixed[a]	Not-mixed[b]
Total capital	$0		$5,750,000		$11,250,000	
Operating						
Sampling prep	$1,320,000		$1,900,000		$60,000	
Sampling[c]	$530,000	$1,380,000 ($1,560,000)	$3,360,000	$5,000,000 ($5,360,000)	$170,000	$300,000 ($350,000)
Transportation	$60,000	$180,000 ($200,000)	$60,000	$180,000 ($200,000)	$60,000	$180,000 ($200,000)
Exposure detriment[d]	$520,000	$1,850,000 ($2,140,000)	$0	$0	$0	$0
Total Operating	$2,430,000	$4,730,000 ($5,220,000)	$5,320,000	$7,080,000 ($7,460,000)	$290,000	$540,000 ($610,000)
Analysis						
Liquid analysis ($4000/sample)	$670,000	$2,400,000 ($2,780,000)	$670,000	$2,400,000 ($2,780,000)	$670,000	$2,400,000 ($2,780,000)
Solid and liquid ($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 handling ($1000/core)	-	-	$170,000	$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	$5,110,000 ($5,920,000)
Total Cost	$3,860,000	$9,840,000 ($11,140,000)	$12,670,000	$18,540,000 ($19,830,000)	$12,970,000	$16,900,000 ($17,780,000)

[a] The costs for the "well-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.

[b] 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.

[c] The sampling costs for the Isolok Sampler are assumed to be $1,000/sample.

[d] The 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 initial 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 and equipment.

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

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 IWFST.

Option 3 has a total cost of $12,970,000 for the "well-mixed" 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 IWFST.

B4.3.3 Schedule

Option 1 does not require any construction and will have no impact 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 criteria.

Option 3 requires the design and construction of a complex sampling facility. The facility consists of long-lead procurement items 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 repairability 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 criteria.

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 Site. 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 criteria.

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

B5.0 REFERENCES

ASME B31.3, 1996 Edition, *Process Piping*, American Society of Mechanical Engineers.

Brown, R. L., 1992, *Cost/Benefit Analysis at Westinghouse Hanford Company*, WHC-SA-1533-FP, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Carlstrom, R. F., 1995, *Sample Pig Transport System Safety Analysis Report for Packaging (Onsite)*, WHC-SD-TP-SARP-001, Rev. 0G, Westinghouse Hanford Company, Richland, Washington.

Carpenter, K. E., 1996, *TWRS Functions and Requirements Document*, WHC-SD-WM-FRD-020, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Carter, E. K., 1989, *Conceptual Design Report: AP Farm Sampling Facility: Project W-006*, SD-W006-CDR-001, Rev. 0, Draft, Westinghouse Hanford Company, Richland, Washington.

Certa, P. J., 1996, *Low-Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-224, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *General Design Criteria*, DOE Order 6430.1A, U.S. Department of Energy, Washington, D.C.

DOE, 1993, *Natural Phenomena Hazards Mitigation*, DOE Order 5480.28, U.S. Department of Energy, Washington, D.C.

DOE, 1995, *TWRS Privatization Requests for Proposals - Draft*, Solicitation Number DE-RP06-96RL13308, U.S. Department of Energy, Richland Operations, Richland, Washington.

Fowler, K. D., 1995, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, WHC-SD-WM-DQO-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Galbraith, J. D., T. B. Salzano, and J. R. Nicholson, 1996a, *Decision Document for Phase I Privatization Transfer System Needs*, WHC-SD-WM-TI-750, Rev. 0, Draft, Westinghouse Hanford Company, Richland, Washington.

Galbraith, J D , 1996b, *Alternative Generation Session for Upgrades of AP-102 and 104*, Meeting Minutes, dated June 13, 1996, Westinghouse Hanford Company, Richland, Washington

Milliken, N J , 1995, *Safety Analysis for Push-Mode and Rotary-Mode Core Sampling*, WHC-SD-WM-SARR-031, Rev 2, Westinghouse Hanford Company, Richland, Washington

Pickett, W W , 1996, Electronic mail to T B Salzano, Re *Cost of RMCS*, August 15, 1996, ICF Kaiser Hanford Company, Richland, Washington

Resource Conservation and Recovery Act of 1976, Public Law 94-580, 90 Stat 2795, 42 USC 6901 et seq

Spohr, R A , 1995, *Analytical Services Fiscal Year 1996 Multi-Year Program Plan*, Rev 1, Westinghouse Hanford Company, Richland, Washington

WAC 173-303-640, 1990, "Dangerous Waste Regulations, Tank Systems," *Washington Administrative Code*, as amended

WHC, 1992a, *Hazardous Material Packaging and Shipping*, WHC-CM-2-14, Westinghouse Hanford Company, Richland, Washington

WHC, 1992b, *Safety Classification of Structures, Systems and Components*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington

WHC, 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1995, *WHC Occupational ALARA Program*, WHC-IP-1043, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1996a, *Operating Specifications for the 241-AN AP, AW, AY, AZ & SY Tank Farms*, OSD-T-151-00007, Westinghouse Hanford Company, Richland, Washington

WHC, 1996b, *Double-Shell Tanks Interim Operational Safety Requirements*, WHC-SD-WM-OSR-016, Rev 0B, Westinghouse Hanford Company, Richland, Washington

WHC, 1996c, *Tank Farm Plant Operating Procedure for Supernatant or Sludge Sampling of All Watchlist and Non-Watchlist Tanks Located in Tank Farm Facilities, excluding SY-Farm*, TO-080-403, Westinghouse Hanford Company, Richland, Washington

WHC, 1996d, *Tank Farm Plant Operating Procedure for Push Mode Sampling of Hydrogen/Flammable Gas Watch-List Tanks and 241-C-103*, TO-080-503, Westinghouse Hanford Company, Richland, Washington

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B6.0 COST ESTIMATES

TWRS CHARACTERIZATION SAMPLING MODULE

General Notes & Instructions

Core Estimate Assumptions

The unit rates used in this module come from ICF KH estimates for the various types of sampling and PT & C for lab work costs. Each estimate on which the module is based contains assumptions as to the number of tanks, expected risers and sampled risers used to generate the estimate. All future estimates generated by the model will incorporate some distortion as the model quantities vary from the original estimates. This distortion will be proportionate to the variance between the quantities used in the original estimate and the model. The assumptions used in developing the unit rates in this model are listed in the table below.

	Estimate	Estimate		Per Tank		Per Riser
Method	Number	Date	Tanks	Selected Risers	Sampled Risers	Segments or Samples
Rotary	T432P058	[illegible]	18	4	2	12
Push	T432P[illegible]	[illegible]	13	3	2	6
Auger	T432P[illegible]	[illegible]	1	4	3	1
Vapor	T43[illegible]	[illegible]	1	2	1	1
Supernate	T435P[illegible]	[illegible]	1	2	1	1

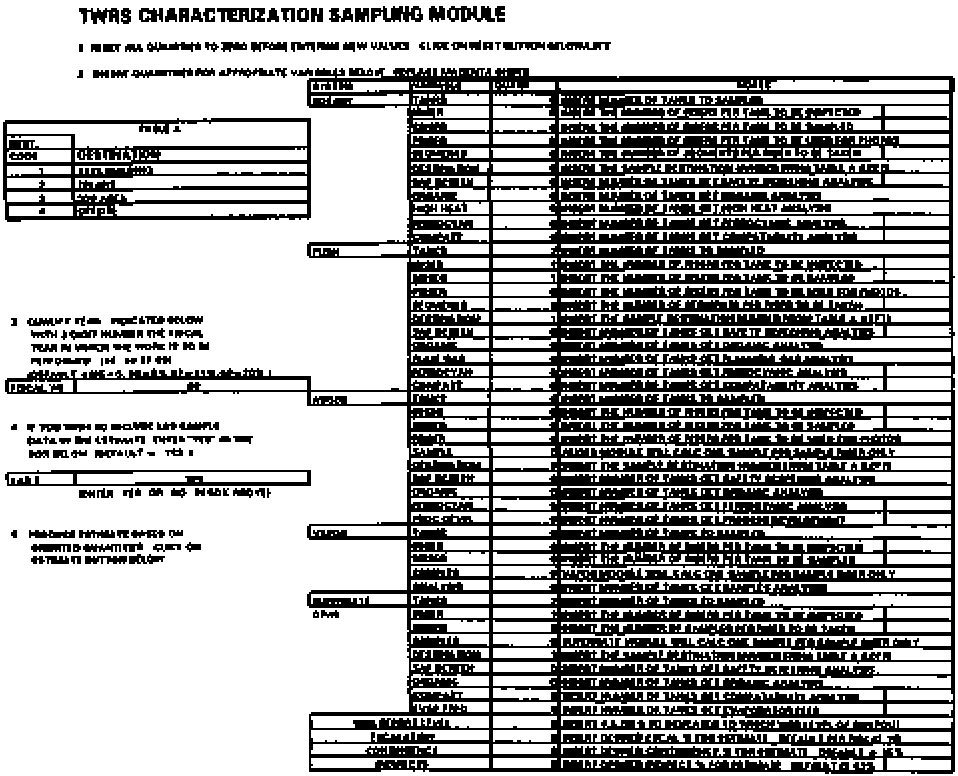
GRAB GRAB

Use of This Module

1 Start by selecting the workbook worksheet and follow the numbered instructions. Numbered instructions are color coded dark red.
2 Instructions and guides are included for all entries required to be inserted by user. These entries are all color coded magenta.
3 Once in the workbook worksheet, the home key on the computer will always bring the user to the beginning of the program.
4 This worksheet is not protected. It has been created to provide maximum flexibility for user. This same feature makes it relatively easy for the base program to become distorted or made inoperable by careless or accidental entries. Should this happen, DO NOT ATTEMPT TO SAVE THIS PROGRAM. Saving the program will preserve damaging entries. If the program should become corrupted simply exit Excel without saving and return to the program. Certain data on these worksheets has been hidden from view to improve program appearance. Do not make any stray entries on the worksheets; a single cell modification in any cell not coded magenta could impair or disable the overall program.
5 Chapter 3 has been updated to include Laboratory costs from LATA/Project Time & Cost, Inc. Analytical Integration Cost Estimate Dated March 1, 1995. Since these are not final costs, this module has extended the same OH & P rates used in the Sampling estimates to the PT & C costs.
6 To print an estimate, click on the print icon from the WorkBook worksheet or select Print from the File menu from the home worksheet.
7 When an estimate is generated by clicking on the estimate button, the program will move to a summary of the estimate. Detail for this estimate is shown in the area directly below the estimate summary at the WBS level selected in the input sheet.
8 To include laboratory costs in the generated estimate, the override box (Step 4) must be filled in with a "YES". This entry in this box will override any entries in the detail boxes for analysis types.

MORE ↓

END



TWRS CHARACTERIZATION SAMPLING MODULE

TABLE A

DESTINATION

Sampling Module Input Page

TWRS CHARACTERIZATION SAMPLING MODULE

This estimate is generated using ICF KH estimates for the various types of sampling. Each estimate, on which this model is based, contains assumptions as to the number of tanks, [illegible] risers and sampled risers used to generate the estimate. Alternate estimates generated by this model will incorporate some distortion as the model quantities vary from the original estimate. This distortion will be proportional to the variance between the quantities used in the original estimate and this model.

ASSUMPTIONS FOR THIS FORECAST

ROTARY		AUGER	
TANKS	[illegible]	TANKS	[illegible]
RISERS	[illegible]	RISERS	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
SEGMENTS	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
ORGANIC	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	VAPOR	
[illegible]	[illegible]	TANKS	[illegible]
[illegible]		[illegible]	[illegible]
TANKS	[illegible]	[illegible]	[illegible]
RISERS	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	GRAB	
[illegible]	[illegible]	TANKS	[illegible]
SEGMENTS	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
ORGANIC	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ORGANIC	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TOTAL DIRECT			$	[illegible]
INDIRECTS		40 %		[illegible]
	SUBTOTAL			[illegible]
ESCALATION		[illegible]		[illegible]
	SUBTOTAL			[illegible]
CONTINGENCY		[illegible] %		[illegible]
	TOTAL		$	[illegible]

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

WBS	ACTIVITY NAME	[illegible]	UNIT	TOT HRS	LABR_TOT	MAT_TOT	SD_TOT	EQ_TOT	OS_TOT	Total
432211	Prerequisites (P)	2	TK	114	3 447	427	0	0	0	3 874
432212	Ramp Inspection (P)	2	WKS	148	4 284	453	0	0	0	4 737
432213	Job Completion (P)	2	TK	4	182	0	0	0	0	182
43221	TOTAL PREREQUISITES	2	TK	266	7 913	880	0	0	0	8 793
432221	Plan Preparation (WP)	2	TK	1 280	43 762	0	0	0	0	43 762
432222	Sample (WP)	2	TK	1 280	43 762	0	0	0	0	43 762
43222	TOTAL WORK PACKAGE PREP	2	TK	2 560	87 524	0	0	0	0	87 524
432231	Pre-Planning Walkdown	2	TK	64	2 380	0	0	0	0	2 380
432232	Planning - Office Support	2	TK	1 012	17 [illegible]	0	0	0	0	17 [illegible]
432233	Field Supervision & Management	2	TK	388	11 200	0	0	0	0	11 200
432241	Receive Work Package	2	EA	4	149	0	0	0	0	149
432242	Mobilize Crews & Equipment	2	EA	1 412	42 530	0	0	0	0	42 530
432243	Prepare to Sample	2	WKS	302	8 778	0	0	0	0	8 778
432244	Perform Sampling	14	SMPL	1 638	48 432	4 915	0	0	0	53 347
432245	Transfer Samples	[illegible]	TRP	91	3 232	1 232	0	0	0	4 464
432246	Demob Crews & Cranes & Crane Cedarrom & Of	2	TK	[illegible]	19 [illegible]	4 311	0	27 900	0	51 [illegible]
432247	Material and Equipment	2	TK	0	0	41 740	30 200	0	0	71 940
432249	Maintenance	2	TK	1 880	58 750	0	0	0	0	58 750
43224	TOTAL SAMPLING	2	TK	6 107	183 834	51 799	30 200	27 900	0	[illegible]
432251	Prerequisites	0	[illegible]	0	0	0	0	0	0	0
432252	Ramp Inspection	0	[illegible]	0	0	0	0	0	0	0
432253	Job Completion	0	[illegible]	0	0	0	0	0	0	0
432254	In-Tank Photo (WP)	0	[illegible]	0	0	0	0	0	0	0
432255	Perform Video Prep	0	[illegible]	0	0	0	0	0	0	0
432256	Perform Video Sampling	0	[illegible]	0	0	0	0	0	0	0
43225	TOTAL IN-TANK PHOTOGRAPHY	0	[illegible]	0	0	0	0	0	0	0
4322	TOTAL [illegible]	2	TK	10 [illegible]	240 [illegible]	52 [illegible]	30 200	27 900	0	441 [illegible]
435011	Prerequisites (P)	2	TK	114	3 491	433	0	0	0	3 924
435012	Ramp Inspection (FIRST TANK(S))	2	WKS	118	3 727	581	0	0	0	4 308
435013	Job Completion (P)	2	TK	4	182	0	0	0	0	182
43501	TOTAL PREREQUISITES	2	TK	246	7 400	1 014	0	0	0	8 414
435021	Plan Preparation (WP)	2	TK	1 280	43 954	0	0	0	0	43 954
435022	Sample (WP)	2	TK	1 280	43 954	0	0	0	0	43 954
43502	TOTAL WORK PACKAGE PREP	2	TK	2 560	87 908	0	0	0	0	87 908
435031	Pre-Planning Walkdown	2	TK	64	2 388	0	0	0	0	2 388
435032	Planning - Field Support	2	TK	317	8 870	0	0	0	0	8 870
435033	Field Supervision and Management	2	TK	56	1 [illegible]	0	0	0	0	1 [illegible]
43503	TOTAL PLANNING	2	TK	437	14 [illegible]	0	0	0	0	14 [illegible]
435041	Receive Work Package	2	TK	4	149	0	0	0	0	149
435042	Mobilize Crews & Equipment	2	TK	44	1 272	0	0	0	0	1 272
435043	Prepare to Sample	14	SMPL	770	22 274	0	0	0	0	22 274
435044	Perform Sampling	14	SMPL	188	5 562	0	0	0	0	5 562
435045	Transfer Samples	14	SMPL	361	11 040	0	1 910	0	0	12 950
435046	Demobilize Crews And Equipment	2	TK	232	6 710	0	0	0	0	6 710
435047	Material and Equipment	2	TK	0	0	7 000	0	0	0	7 000
43504	TOTAL SAMPLING	2	TK	1 602	47 [illegible]	7 000	1 910	0	0	57 [illegible]
4350	TOTAL SUPERNATE SAMPLING (DRAIN)	2	TK	4 [illegible]	158 [illegible]	8 [illegible]	1 910	0	0	167 [illegible]

TWRS CHARACTERIZATION SAMPLING MODULE

This estimate is generated using ICF KH estimates for the various types of sampling. Each estimate, on which this model is based, contains assumptions as to the number of tanks, inspected risers and sampled risers used to generate the estimate. Alternate estimates generated by this model will incorporate some distortion as the model quantities vary from the original estimate. This distortion will be proportionate to the variance between the quantities used in the original estimate and this model.

ASSUMPTIONS FOR THIS FORECAST

ROTARY		AUGER	
TANKS	0	TANKS	0
RISERS	0	RISERS	0
[illegible]	0	[illegible]	0
[illegible]	0	[illegible]	0
SEGMENTS	0	[illegible]	0
[illegible]	0	SAF SCRN	0
SAF ACID	0	[illegible]	0
ORGANIC	0	[illegible]	0
HIGH HEAT	0	PROC QTY	0
ENERGY	0	VAPOR	
COMPAT IT	0	TANKS	0
PUSH		RISERS	0
TANKS	1	[illegible]	0
RISERS	1	SAMPLE TYPE	0
[illegible]	7	GRAB	
[illegible]	8	TANKS	0
SEGMENTS	38	[illegible]	1
DSC II	0	[illegible]	[illegible]
SAF SCRN	0	DSC	1
ORGANIC	0	SAF SCRN	0
FLAM GAS	0	ORGANIC	0
ENERGY	0	COMPAT IT	0
COMPAT IT	0	[illegible]	0

TOTAL DIRECT			$	[illegible]
INDIRECTS		40 %		[illegible]
	SUBTOTAL			[illegible]
ESCALATION		[illegible]		[illegible]
	SUBTOTAL			[illegible]
CONTINGENCY		[illegible]		[illegible]
	TOTAL		$	[illegible]

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

WBS	DESCRIPTION	QUAN	UNIT	TOT MHR	LABR TOT	MAT TOT	SU TOT	EQ TOT	OH TOT	TOTAL
432111	Prerequisites (PR)	2	TK	116	3 443	432	0	0	0	3 875
432112	Riser Inspection (PR)	2	[illegible]	148	4 284	453	0	0	0	4 737
432113	Job Completion (PR)	2	TK	4	133	0	0	0	0	133
43211	TOTAL PREREQUISITES	2	TK	268	7 860	885	0	0	0	8 745
432121	Plan Preparation (WP)	2	TK	1 380	43 762	0	0	0	0	43 762
432122	Sample (WP)	2	TK	1 380	43 762	0	0	0	0	43 762
43212	TOTAL WORK PACKAGE PREP	2	TK	2 760	87 524	0	0	0	0	87 524
432131	Pre-Planning Walkdown	2	TK	88	2 280	0	0	0	0	2 280
432132	Planning - Office Support	2	TK	1 512	47 892	0	0	0	0	47 892
432133	Field Supervision & Management	2	TK	360	11 200	0	0	0	0	11 200
432141	Receive Work Package	2	EA	4	148	0	0	0	0	148
432142	Mobilize Crews & Equipment	2	EA	1 472	42 528	0	0	0	0	42 528
432143	Prepare to Sample	2	[illegible]	332	9 772	0	0	0	0	9 772
432144	Perform Sampling	82	SEG	5 306	157 413	14 014	0	0	0	171 427
432145	Transfer Samples	17	TRIP	388	10 [illegible]	4 [illegible]	0	0	0	14 [illegible]
432146	Operate Crane & Crane Equipment & [illegible]	2	TK	[illegible]	[illegible]	14 017	0	27 700	0	71 [illegible]
432147	Material and Equipment	2	TK	0	0	41 782	39 360	0	0	81 [illegible]
432148	Maintenance	2	TK	1 [illegible]	58 758	0	0	0	0	58 758
43214	TOTAL SAMPLING	2	TK	10 [illegible]	309 [illegible]	74 [illegible]	39 360	27 700	0	451 [illegible]
432151	Prerequisites	0	[illegible]	0	0	0	0	0	0	0
432152	Riser Inspection	0	[illegible]	0	0	0	0	0	0	0
432153	Job Completion	0	[illegible]	0	0	0	0	0	0	0
432154	In-Tank Photo (WP)	0	[illegible]	0	0	0	0	0	0	0
432155	Perform Video Plan Prep	0	[illegible]	0	0	0	0	0	0	0
432156	Perform Video Sampling	0	[illegible]	0	0	0	0	0	0	0
43215	TOTAL IN TANK PHOTOGRAPHY	0	[illegible]	0	0	0	0	0	0	0
4322	TOTAL PUSH	2	TK	[illegible]	[illegible]	74 [illegible]	39 360	27 700	0	[illegible]
435011	Prerequisites (PR)	2	TK	114	3 404	432	0	0	0	3 836
435012	Riser Inspection (PORT2 TANK(S))	2	[illegible]	128	3 727	451	0	0	0	4 178
435013	Job Completion (PR)	2	TK	4	133	0	0	0	0	133
43501	TOTAL PREREQUISITES	2	TK	246	7 [illegible]	883	0	0	0	8 [illegible]
435021	Plan Preparation (WP)	2	TK	1 380	43 654	0	0	0	0	43 654
435022	Sample (WP)	2	TK	1 380	43 654	0	0	0	0	43 654
43502	TOTAL WORK PACKAGE PREP	2	TK	2 760	87 308	0	0	0	0	87 308
435031	Pre-Planning Walkdown	2	TK	44	[illegible]	0	0	0	0	[illegible]
435032	Planning - Field Support	2	TK	312	[illegible]	0	0	0	0	[illegible]
435033	Field Supervision and Management	2	TK	[illegible]	1 [illegible]	0	0	0	0	1 [illegible]
43503	TOTAL PLANNING	2	TK	420	14 [illegible]	0	0	0	0	14 [illegible]
435041	Receive Work Package	2	TK	4	148	0	0	0	0	148
435042	Mobilize Crews & Equipment	2	TK	44	1 272	0	0	0	0	1 272
435043	Prepare to Sample	50	[illegible]	2 750	[illegible]	0	0	0	0	[illegible]
435044	Perform Sampling	50	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]
435045	Transfer Samples	50	[illegible]	1 250	43 [illegible]	0	5 750	0	0	48 [illegible]
435046	Demobilize Crews And Equipment	2	TK	[illegible]	6 710	0	0	0	0	6 710
435047	Material and Equipment	2	TK	0	0	7 [illegible]	0	0	0	7 [illegible]
43504	TOTAL SAMPLING	2	TK	[illegible]	180 [illegible]	7 [illegible]	5 750	0	0	[illegible]
4350	TOTAL SUPERNATE SAMPLING (GRAB)	2	TK	[illegible]	[illegible]	[illegible]	5 750	0	0	[illegible]

TWRS CHARACTERIZATION SAMPLING MODULE

This estimate is generated using ICF KH estimates for the various types of sampling. Each estimate, on which this model is based, contains assumptions as to the number of tanks, inspected risers and sampled risers used to generate the estimate. Alternate estimates generated by this model will incorporate some distortion as the model quantities vary from the original estimate. This distortion will be proportionate to the variance between the quantities used in the original estimate and this model.

ASSUMPTIONS FOR THIS FORECAST

ROTARY		AUGER	
TANKS	[illegible]	TANKS	0
INSPR	1	INSPR	0
SMPLR	1	SMPLR	1
PHASES	0	PHASES	0
SEGMENTS	0	DSC	1
DSC	1	SAF SCRN	1
SAF SCRN	0	ORGANIC	1
ORGANIC	0	FERROCY	1
HIGH HEAT	0	PROC DEV	0
FERROCY	0	VAPOR	
COMPAT	0	TANKS	1
PUSH		INSPR	1
TANKS	[illegible]	SMPLR	0
INSPR	1	ANALYSES	0
SMPLR	1	GRAB	
PHASES	0	TANKS	2
SEGMENTS	[illegible]	INSPR	1
DSC	1	SMPLR	34
SAF SCRN	[illegible]	DSC	1
ORGANIC	0	SAF SCRN	0
FLAM GAS	0	ORGANIC	0
FERROCY	0	COMPAT	0
COMPAT	0	EXP FEED	0

TOTAL DIRECT			$	[illegible]
INDIRECTS		[illegible] %		[illegible]
	SUBTOTAL			[illegible]
ESCALATION		20%		[illegible]
	SUBTOTAL			[illegible]
CONTINGENCY		[illegible] %		[illegible]
	TOTAL		$	[illegible]

"Not-Mixed" Waste Scenario Work Breakdown Structure Report (5 Percent Solids)

WBS	Description	QUAN	UNIT	TOT MHR	LABR TOT	MAT TOT	[illegible] TOT	SO TOT	EQ_TOT	TOTAL
4321211	Prerequisites (4)	2	TK	114	3 442	432	0	0	0	3 874
4321212	Riser Inspection (4)	2	RSR	148	4 252	485	0	0	0	4 737
4322213	Job Completion (4)	2	TK	4	132	0	0	0	0	132
43221	TOTAL PREREQUISITES	2	TK	266	7 826	917	0	0	0	8 743
4322221	Riser Preparation (WP)	2	TK	1 340	43 782	0	0	0	0	43 782
4322221	Sample (WP)	2	TK	1 340	43 742	0	0	0	0	43 742
43222	TOTAL WORK PACKAGE PREP	2	TK	2 680	87 524	0	0	0	0	87 524
4322231	Pre-Planning Walkdown	2	TK	84	2 380	0	0	0	0	2 380
4322232	Planning - Office Support	2	TK	1 512	47 052	0	0	0	0	47 052
4322233	Field Supervision & Management	2	TK	380	11 200	0	0	0	0	11 200
4322241	Receive Work Package	2	EA	4	148	0	0	0	0	148
4322242	Mobilize Crews & Equipment	2	EA	1 472	42 528	0	0	0	0	42 528
4322243	Prepare to Sample	2	[illegible]	192	5 773	0	0	0	0	5 773
4322244	Perform Sampling	50	[illegible]	6 120	151 630	16 170	0	0	0	167 800
4322245	Transfer Samples	30	TRIP	390	13 176	4 498	0	0	0	17 674
4322246	Demob Crews & Decon Equipment & QI	2	TK	1 054	37 436	10 108	0	27 700	0	75 244
4322247	Material and Equipment	2	TK	0	0	41 782	29 200	0	0	70 982
4322248	Maintenance	2	TK	1 990	53 788	0	0	0	0	53 788
43224	TOTAL SAMPLING	2	TK	11 325	317 401	78 657	29 200	27 700	0	404 840
4322251	Prerequisites	0	PTRM	0	0	0	0	0	0	0
4322252	Riser Inspection	0	PTRM	0	0	0	0	0	0	0
4322253	Job Completion	0	PTRM	0	0	0	0	0	0	0
4322254	In Tank Riser (WP)	0	PTRM	0	0	0	0	0	0	0
4322255	Perform Video Riser Prep	0	PTRM	0	0	0	0	0	0	0
4322256	Perform Video Sampling	0	PTRM	0	0	0	0	0	0	0
43225	TOTAL IN TANK PHOTOGRAPHY	0	PTRM	0	0	0	0	0	0	0
4322	TOTAL [illegible]	2	TK	18 457	[illegible]	79 [illegible]	29 200	27 700	0	[illegible]
4350111	Prerequisites (4)	2	TK	114	3 404	432	0	0	0	3 836
4350112	Riser Inspection (SINGLE TANK(S?))	2	RSR	176	3 727	481	0	0	0	4 208
4350113	Job Completion (4)	2	TK	4	132	0	0	0	0	132
43501	TOTAL PREREQUISITES	2	TK	294	7 263	913	0	0	0	8 176
4350121	Riser Preparation (WP)	2	TK	1 300	43 654	0	0	0	0	43 654
4350122	Sample (WP)	2	TK	1 300	43 654	0	0	0	0	43 654
43502	TOTAL WORK PACKAGE PREP	2	TK	2 600	87 308	0	0	0	0	87 308
4350131	Pre-Planning Walkdown	2	TK	84	2 380	0	0	0	0	2 380
4350132	Planning - Field Support	2	TK	312	9 870	0	0	0	0	9 870
4350133	Field Supervision and Management	2	TK	60	1 980	0	0	0	0	1 980
43503	TOTAL PLANNING	2	TK	456	14 230	0	0	0	0	14 230
4350141	Receive Work Package	2	TK	4	148	0	0	0	0	148
4350142	Mobilize Crews & Equipment	2	TK	44	1 272	0	0	0	0	1 272
4350143	Prepare to Sample	88	[illegible]	2 [illegible]	82 278	0	0	0	0	82 278
4350144	Perform Sampling	88	[illegible]	788	22 744	0	0	0	0	22 744
4350145	Transfer Samples	88	[illegible]	1 408	40 [illegible]	0	8 470	0	0	48 [illegible]
4350146	Demobilize Crews and Equipment	2	TK	298	8 710	0	0	0	0	8 710
4350147	Material and Equipment	2	TK	0	0	7 [illegible]	0	0	0	7 [illegible]
43504	TOTAL SAMPLING	2	TK	5 [illegible]	173 [illegible]	7 [illegible]	8 470	0	0	[illegible]
4350	TOTAL SUPERNATE SAMPLING (GRAB)	2	TK	9 [illegible]	281 [illegible]	8 [illegible]	8 470	0	0	297 [illegible]

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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 mixer pumps that may be installed in tanks 241-AP-102 and 241-AP-104 These tanks 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 + pump 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 limit of 180°F the pump may be operated for 75 h/wk

The maximum rate of temperature rise 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 (Rieck 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

1 The total primary airflow rate is increased by more than 25 percent

2 One (or more) of the AP tanks is added to the flammable gas watchlist

3 The safety classification of the ventilation system is upgraded

If the existing system is judged unsuitable (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 recommends 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 ammonia 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, drainage piping, new seal pot and pit, and demolition and burial of the existing system The W-314 project Tri-Party Agreement milestone 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

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

Outputs from the program included

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

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

1. 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 at full power was determined

C4.0 UNCERTAINTIES

1. The capacity requirement of the mixer pumps is not certain Higher power pumps will require shorter operating periods

2. The existing underground single wall ventilation 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

Briggs, S R , 1996, *Conceptual Design Report for Tank Farm Restoration and Safe Operations Project W-314*, WHC-SD-W314-CDR-001, Rev 0, Westinghouse Hanford Company, Richland, Washington

Haubach, E C , *Interim Operational Safety Requirements for Double-Shell Tanks*, WHC-SD-WM-OSR-016, Rev 0B, Westinghouse Hanford Company, Richland, Washington

ICF KH, 1995, *241-AP Tank Farm Ventilation Study*, P80100LR, ICF Kaiser Hanford Company, Richland, Washington

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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C4.0 CALCULATION

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

KAISER ENGINEERS HANFORD	**CALCULATION IDENTIFICATION AND INDEX**	Page 1 of 1 Date 6/21/96

This sheet shows the status and disposition of the attached Design Analysis sheets.

Discipline HVAC W.O./Job No. E23560 Calculation No. H-01

Project No. & Name TWRS Privatization Phase I

Calculation Item AP Tank Farm HVAC Thermal Analysis

These calculations apply to:

Dwg. No. ____ Rev. No. ____

Dwg. No. ____ Rev. No. ____

Other (Study, CDR) TEST Decision Document

____ Rev. No. ____

The status of these calculations is: (✓)

☒ Preliminary Calculations

☐ Final Calculations

☐ Check Calculations (On Calculation Dated) ____

☐ Void Calculation (Reason Voided) ____

Incorporated in Final Drawings? ☐ Yes ☒ No

This calculation verified by independent "check" calculations? ☐ Yes ☒ No

Original and Revised Calculation Approvals

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	6/21/96		
Checked by	6/25/96		
Approved by			
Checked Against Approved Vendor Data			

INDEX

Design Analysis Page No.	Description
1	OBJECTIVE, CRITERIA, GIVEN DATA, ASSUMPTIONS
2	REFERENCES, FINDINGS & CONCLUSIONS, CALCULATIONS
3-5	CALCULATIONS
A1-A4	COMPUTER CALC. OUTPUT

KEH 0278.00 (04/92)

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HANFORD

DESIGN ANALYSIS

Calc No H-01
Revision 0
Page No. 1 of 5

Client WHC
Subject AP Thermal Analysis
Location 200 E
WO/Job No E23360
Date 6/14/96 By PD Rice
Checked 6/25/96 By E [illegible]
Revised By

1.0 OBJECTIVE

The objective of this calculation is to determine permissable periods of operation of mixer pumps in tanks AP-102 and AP-104.

2.0 CRITERIA

a) DOE 6430.1A, General Design Criteria

3.0 GIVEN DATA

a) Existing ventilation system total primary flow = 1170 cfm
b) Existing ventilation system total annulus flow = 3600 cfm
c) Mixer pump capacity = 300 hp (each).
d) Six tanks will remain in the system (Privatization will take over two of existing eight tanks)
e) max allowed radiolytic heat = 70,000 Btu/h per tank
f) max allowed bulk waste temp = 180 °F

4.0 ASSUMPTIONS

a) average summer air temp = 77 °F, humidity = 40%
b) Tank waste vapor suppression factor = .95
c) average primary airflow in tank = 195 scfm
d) average annulus airflow = 1433 scfm
e) Tank contents ~ 500,000 gal, $C_p = 1.0$, $\rho = 1.2$

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DESIGN ANALYSIS

Calc No H-01
Revision
Page No 2 of 5

Client WHC
W.O./Job No E23360
Subject AP Thermal Analysis
Date 6/14/94 By PD Rice
Checked 6/16/94 By [illegible]
Location 200 E
Revised By

5.0 REFERENCES

1) WHC-SD-WM-OSR-016, Rev. 0

2) OSD-T-151-00007, Rev. H-12

3) Crowley, K.R., 1994, "Results from Evaporation Test to Support Heat Removal System Design", WHC-SD-W236A-ER-010, Rev. 0

4) Crea, B.A., 1994, "Results from Evaporation Test To Support The MWTF Heat Removal System Design", WHC-SD-W236A-ER-004.

6.0 FINDINGS and CONCLUSIONS

The results of the thermal analysis of AP Tanks show that mixer pumps may be operated intermittently without exceeding OSR limits. The existing ventilation system has sufficient capacity. For example, a tank having a radiolytic heat load of 50,000 Btu/hr will permit operation of a 300 hp mixer pump for 4 hrs/wk without exceeding an average total heat load of 70,000 Btu/hr. Using a maximum bulk temperature of 180 °F as criteria, a tank having a radiolytic heat load of 50,000 Btu/hr will permit operation of a 300 hp mixer pump for 75 hrs/wk.

7.0 CALCULATIONS

a) References 3) and 4) were used to model existing conditions in a typical AP Tank. Pg. 1 of Appendix A results in a waste temperature of 76 °F assuming a primary airflow rate of 196 scfm and an annulus flow of 1433 scfm. The radiolytic heat load used was 50,000 Btu/hr.

b) Fig. A-2 shows the effect of increasing the total heat load (shared by rad heat and pump heat) to 70,000 Btu/hr, the maximum rad. heat for AP tanks (ref. 1 & 2). Fig 6 shows the relationship between mixer pump operation and radiolytic heat

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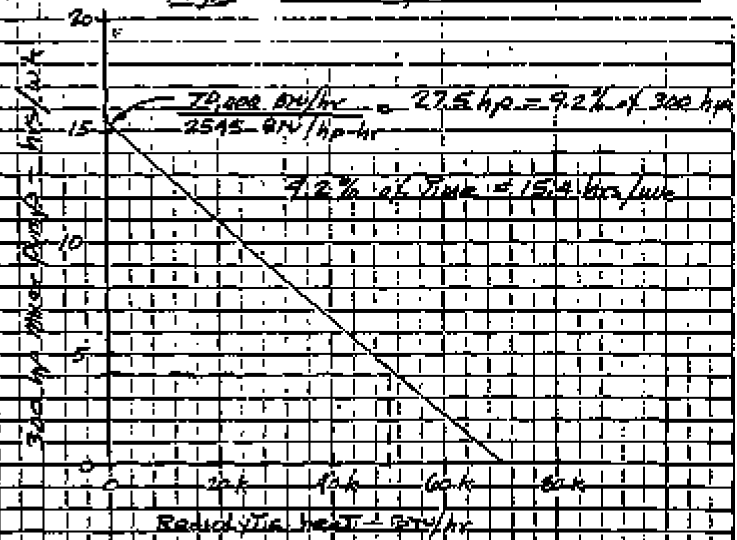
DESIGN ANALYSIS

Calc. No. U-01
Revision 0
Page No. 3 of 5

Client WHC
WO/Job No. E23380
Subject AP Thermal Analysis
Date 6/18/96 By RD Rie.
Checked 6/26/96 By E Dalpiaz
Location 200 E
Revised By

Calculations (cont)

Fig. 1 – 70,000 Btu/hr Total Heat Criteria*



* 195 scfm primary airflow,
1933 scfm annulus airflow

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HANFORD

DESIGN ANALYSIS

Calc. No. H-01
Revision 0
Page No 4 of 5

Client WHC
Subject AP Thermal Analysis
Location 200 E
WO/Job No. E23580
Date 6/14/96 By PD Rile
Checked 6/15/96 By [illegible]
Revised By

Calculations: (cont)

c) Figs A-7 & A-9 show the effect of adding mixer pump heat in quantities that would drive the average bulk temperature to the OSR limit of 180°F (ref. 1). The results are shown graphically in Fig 3.

d) The maximum rate of temperature rise will occur just after the mixer pump is started and at low tank temperature (i.e. minimum heat transfer from tank to surroundings).

waste temp rise = (Rad. heat + Pump heat − Tank loss, BTU/hr) / (waste heat capacity, BTU/°F)

$$= \frac{(Q_R + Q_P - Q_L)}{(C_p)(M)} \approx \frac{Q_P}{C_p (M)} \;\; °F/hr$$

$$= \frac{(300\,hp)(2545\ BTU/hp\text{-}hr)}{(40)(1.2)(600{,}000)(0.3)} = 0.15\ °F/hr = 3.7\ °F/day$$

This is a conservative result based on the values used for the waste heat capacity.

The expected temperature variation is shown qualitatively in fig 2:

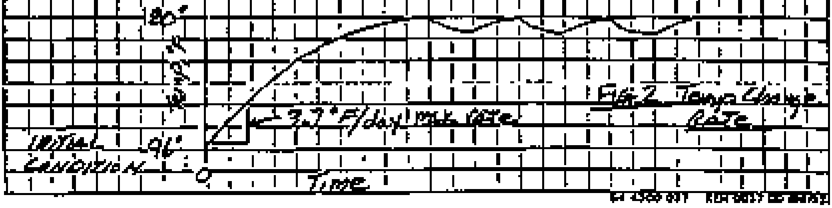

Fig 2 Temp Change Rate

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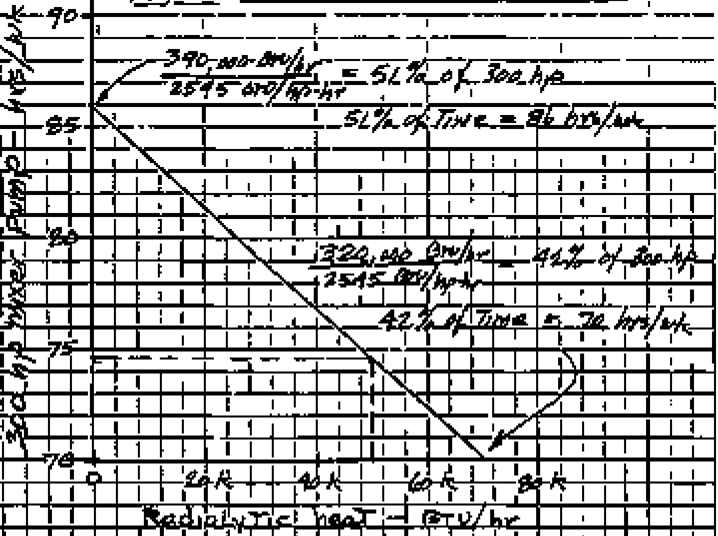
DESIGN ANALYSIS

Calc No H-01
Revision 0
Page No 5 of 5

Client WHC
Subject AY Thermal Analysis
Location 200 E
WO/Job No E23380
Date 6/12/96 By PD Rice
Checked 6/13/96 By E [illegible]
Revised By

Calculations (Cont.)

Fig 3. 180°F Waste Criteria *



$$\frac{390{,}000\ \text{BTU/hr}}{2545\ \text{BTU/hp-hr}} = 51\%\ \text{of}\ 300\ \text{hp}$$

51% of Time = 86 hrs/wk

$$\frac{320{,}000\ \text{BTU/hr}}{2545\ \text{BTU/hp-hr}} = 42\%\ \text{of}\ 300\ \text{hp}$$

42% of Time = 72 hrs/wk

* 195 scfm primary airflow,
1433 scfm annulus airflow

Initial Condition

```
Pump Heat =  0 Btu/h          Radionuclide Heat =  50000 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 Depth =  10.5 ft
Concrete Depth =  1.25 ft     Outside Air Temp =  77 F


Soln     Soln    Annulus   Conduct     Net      Exit    Required  Va Exit    Ann. Ex.
Temp.     vp      Loss      Loss       Evap    Hum Ra     Flow     Cond       Temp
 F      mm Hg    Btu/h     Btu/h     lbH2O/h  lbw/lbda    scfm    F / %RH      F

Waste temperature is too high. Will try next temperature step(A).
103.0    29.5      37147.    9567.     2.37    0.025      30.68  101.6     56.8     100.6
101.0    27.8      34116.    8995.     4.98    0.024      70.13   99.3     57.5      98.7
 99.0    26.2      31094.    8429.     7.53    0.022     119.78   97.2     56.9      96.8
 97.0    24.6      28083.    7862.    10.05    0.020     182.09   95.0     56.3      94.8
 95.0    23.2      25085.    7297.    12.55    0.019     261.64   92.8     55.5      92.9
 93.0    21.8      22102.    6733.    15.04    0.017     365.59   90.7     54.7      91.0
 91.0    20.5      19137.    6173.    17.53    0.016     506.65   88.5     53.6      89.2
 89.0    19.2      16195.    5617.    20.03    0.014     702.40   86.4     52.4      87.3
 87.0    18.1      13280.    5070.    22.56    0.013     995.49   84.4     51.0      85.4
 85.0    16.9      10401.    4536.    25.14    0.012    1471.27   82.4     49.2      83.6
 83.0    15.9       7573.    4025.    27.74    0.011    2353.20   80.6     47.0      81.8
 81.0    14.9       4820.    3559.    30.00    0.009    4351.93   79.1     44.4      80.1
```

70,000 BTU/h Total

Pump Heat = 50000 Btu/h   Radionuclide Heat = 20000 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 Depth = 10.5 ft
Concrete Depth = 1.25 ft   Outside Air Temp = 77 F

Soln Temp. F	Soln vp mm Hg	Annulus Loss Btu/h	Conduct Loss Btu/h	Net Evap lbH2O/h	Exit Hum Ra lbw/lbda	Required Flow scfm	Vs Exit Cond F /	%RH	Ann. Ex. Temp F
110.0	36.2	47817.	11327.	8.01	0.031	76.78	107.7	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	0.027 105	154.99	103.3	57.4	103.6
104.0	30.4	38666.	9629.	15.67	0.025	206.29	101.1	56.9	101.6
102.0	28.7	35630.	9062.	18.15	0.023	268.77	98.9	56.4	99.6
100.0	27.0	32604.	8495.	20.60	0.021	345.89	96.8	55.7	97.7
98.0	25.4	29587.	7929.	23.02	0.019	442.71	94.6	55.0	95.8
96.0	23.9	26583.	7364.	25.42	0.018	566.90	92.4	54.2	93.9
94.0	22.5	23592.	6801.	27.80	0.016	730.67	90.3	53.2	92.0
92.0	21.1	20617.	6241.	30.18	0.015	954.69	88.1	52.0	90.1
90.0	19.8	17663.	5687.	32.55	0.014	1276.81	86.0	50.7	88.2
88.0	18.6	14733.	5141.	34.92	0.012	1773.81	84.0	49.0	86.4
86.0	17.5	11835.	4611.	37.24	0.011	2625.12	82.1	47.1	84.5

390,00 BTU/h Total

Pump Heat = 340000 Btu/h   Radionuclide Heat = 50000 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 Depth = 10.5 ft
Concrete Depth = 1.25 ft   Outside Air Temp = 77 F

Soln Temp. F	Soln vp mm Hg	Annulus Loss Btu/h	Conduct Loss Btu/h	Net Evap lbH2O/h	Exit Hum Ra lbw/lbda	Required Flow scfm	Vt Exit Cond F / %RH		Ann. Ex. Temp F
180.0	213.5	156554.	29343.	186.16	0.224	190.75	171.5	62.5	176.4
178.0	204.2	153424.	28776.	188.48	0.209	206.86	169.3	62.6	174.5
176.0	195.3	150295.	28208.	190.74	0.196	224.22	167.1	62.6	172.5
174.0	186.7	147167.	27638.	192.96	0.183	242.95	164.9	62.7	170.5
172.0	178.4	144040.	27067.	195.12	0.172	263.17	162.7	62.7	168.5
170.0	170.4	140913.	26495.	197.23	0.161	285.01	160.5	62.8	166.5
168.0	162.7	137787.	25921.	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.	24770.	203.23	0.132	361.98	153.7	62.9	160.6
162.0	141.3	128416.	24192.	205.12	0.124	392.12	151.5	62.9	158.6
160.0	134.8	125293.	23613.	206.94	0.116	424.90	149.2	62.9	156.6
158.0	128.5	122173.	23033.	208.70	0.108	460.63	146.9	62.9	154.6
156.0	122.4	119053.	22451.	210.40	0.101	499.63	144.7	62.9	152.6
154.0	116.6	115934.	21868.	212.04	0.094	542.29	142.4	62.8	150.6
152.0	111.0	112817.	21283.	213.60	0.088	589.09	140.1	62.8	148.7
150.0	105.7	109700.	20697.	215.10	0.082	640.53	137.7	62.7	146.7
148.0	100.6	106586.	20110.	216.52	0.077	697.26	135.4	62.5	144.7
146.0	95.7	103472.	19521.	217.87	0.071	759.99	133.1	62.4	142.7
144.0	91.0	100360.	18930.	219.14	0.066	829.61	130.7	62.2	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	0.053	1091.55	123.6	61.4	134.8
136.0	74.0	87930.	16552.	223.38	0.049	1201.83	121.2	61.0	132.9
134.0	70.3	84827.	15953.	224.21	0.045	1327.26	118.8	60.6	130.9
132.0	66.6	81726.	15352.	224.92	0.042	1470.87	116.4	60.1	128.9
130.0	63.2	78628.	14750.	225.53	0.038	1636.60	114.0	59.5	126.9

390,000 BTU/h Total

```
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 Depth =  10.5 ft
Concrete Depth =  1.25 ft    Outside Air Temp =  77 F
```

Soln Temp. F	Soln vp mm Hg	Annulus Loss Btu/h	Conduct Loss Btu/h	Net Evap lbH2O/h	Exit Hum Rt lbw/lbda	Required Flow scfm	Vs Exit Cond F / %RH		Ann. Ex. Temp F
180.0	213.5	156554.	29343.	186.16	0.224	190.75	171.5	62.5	176.4
178.0	204.2	153424.	28776.	188.48	0.209	206.86	169.3	62.6	174.5
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174.0	186.7	147167.	27638.	192.96	0.183	242.95	164.9	62.7	170.5
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170.0	170.4	140913.	26495.	197.23	0.161	285.01	160.5	62.8	166.5
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158.0	128.5	122173.	23033.	208.70	0.108	460.63	146.9	62.9	154.6
156.0	122.4	119053.	22451.	210.40	0.101	499.63	144.7	62.9	152.6
154.0	116.6	115934.	21868.	212.04	0.094	542.29	142.4	62.8	150.6
152.0	111.0	112817.	21283.	213.60	0.088	589.09	140.1	62.8	148.7
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148.0	100.6	106586.	20110.	216.52	0.077	697.25	135.4	62.5	144.7
146.0	95.7	103472.	19521.	217.87	0.071	759.99	133.1	62.4	142.7
144.0	91.0	100360.	18930.	219.14	0.066	829.61	130.7	62.2	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	0.053	1091.55	123.6	61.4	134.8
136.0	74.0	87930.	16552.	223.38	0.049	1201.83	121.2	61.0	132.9
134.0	70.3	84827.	15953.	224.21	0.045	1327.26	118.8	60.6	130.9
132.0	66.6	81726.	15352.	224.92	0.042	1470.87	116.4	60.1	128.9
130.0	63.2	78628.	14750.	225.53	0.038	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

D1.1 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, permitting, 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) (DOE-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 sludges; 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 IWFSTs 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-RL 1996).
- Tanks 241-AP-102 and 241-AP-104 will be used as the IWFSTs (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 tie-in point with the contractor will be determined upon completion of contract negotiations.

- The piping design temperature is 93 °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 ft) of soil and 0.6 m (2 ft) thick 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 criterion for determining the best option was based primarily on cost and whether the option met the topography requirements in Certa et al (1996)

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

Decision criteria	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	$1,900,000	$2,750,000
Leak detection	Separate leak detection element (LDE) for high-level waste (HLW) line and the transfer pumps in tanks 241-AP-102 and 241-AP-104	Common LDE for HLW line and the transfer pump on tank 241-AP-102	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
Maintainability	Easy access	Tight access	Easy access
Meets required hydraulic characteristics	Yes	Yes	Yes

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-cm (12-in) riser This pit could be used in the future for in-tank equipment where as the pit in Option 1 could only be used for the scope of Phase I privatization

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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 (Galbraith et al 1996) This includes the requirements for tieing into an existing line, installing a new valve pit, tieing into 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 privatization 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 confining tank waste during transfers The design, construction, and operation of the transfer lines shall establish multiple barriers 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/unmitigated 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 including DBAs) that preclude offsite releases that would cause doses 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 accidents that can be anticipated as occurring during the facility lifetime such as radioactive material spills

D4.1.2 Operational Function

Gravity drained piping shall be installed with a slope that results in a liquid 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 hydraulic requirements The piping shall be sized to handle 150 percent of the maximum design liquid waste flow rate (WHC 1994)

The waste pumpability 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 Galbraith 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 (8 5 ft/s) in a 5 08-cm (2-in) transfer line

Following 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 (Galbraith 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 1996 and Fowler 1995a)

D4.1.3 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 meet 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 *Maintainability*

The design shall provide for routine maintenance and repair 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

Piping 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 air or nitrogen for pneumatic 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 corrosion resistant (e.g., lined with suitable synthetic resin materials or made of stainless 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 seismic induced stresses resulting from seismic waves Peak ground velocity shall be calculated to GCLOAD-01 Seismic wave velocities for the determination of seismic strain shall not be less than 610 m/s (2,000 ft/s) The effect of the seismic anchor movements and permanent settlements of the structure to which these pipes are anchored shall be considered The potential for ground-failure phenomena such as soil liquefaction, land slides, gross surface settlement, collapse of voids, and instability of soil slopes shall be considered in the design of underground process pipes

D4.2.3 Burial

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 Cathodic Protection

The design 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 Insulating 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 sealed 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 handled 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 for the transfer lines and connections. The coatings enable the secondary coating to be compatible with transferred waste and prevent degradation of the secondary containment due to physical contact with the waste (40 CFR Part 265 and 40 CFR Part 280).

The protective coating 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 coating shall be applied to a level equal to or above where the nozzles 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 ease with which radioactive contamination can be removed, typically measured by the decontamination factor (DF) A coating that demonstrates a minimum DF of 50 as determined by ASTM D-4256, Method A The DF after an initial wash with 120 to 160 psi 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 inch (psig) line pressure within one hour (WAC-173-303, Section 350, 3)

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 secondary system within 24 hours, or at earliest practical time if the existing 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 I, 3 c(2)(g))

D4.3.4 Valve Pit Cover Blocks

The pit cover blocks shall form part of the secondary confinement barrier 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 or 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 secondary 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 penetrations 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 coating to prevent the migration of contamination and improve the ease of decontamination.

D4.4 PROCESS PIPING MODIFICATIONS

Several decision criteria 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 incurred 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

Option 1 would locate a new valve pit 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 line would be routed from the new valve pit to tank 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-in.) drain line from the valve pit floor drain would be routed to a spare riser on tank 241-AP-102. The jumper 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 routed directly to the HLW privatization contractor. The jumper arrangement for Option 1 is shown in Section 7.0, Figure D7-3, while hydraulic diagrams are shown in Figures D7-4 through D7-6. 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 HLW Processing Facility at the same time that LAW is being transferred from the IWPSTs to either tank 241-AP-106 or 241-AP-108. This simultaneous transfer is possible since the two transfer routes do not share 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 pit 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 jumpers 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 pump from the valve arrangement to support the Phase I transfer 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 D7-14, 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 $2,750,000. 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 valve 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 valve 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 routing 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 enlarged to accommodate the transfer line valves and jumpers. By combining tasks, construction costs could be reduced over building a new valve pit (Option 1). In addition, adequate room for maintenance and repair work can be incorporated 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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D6.0 REFERENCES

40 CFR Part 265, 1996, *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*, U S Code of Federal Regulations, U S Nuclear Regulatory Commission, Washington, D C

40 CFR Part 191, 1996, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel High-Level and Transuranic Radioactive Wastes*, U S Code of Federal Regulations, U S Nuclear Regulatory Commission, Washington, D C

40 CFR Part 280, 1996, *Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks*, U S Code of Federal Regulations, U S Nuclear Regulatory Commission, Washington, D C

ACI 349-90, *Code Requirements for Nuclear Safety Related Concrete Structures*, American Concrete Institute, Detroit, Michigan

ASME B31 3, 1996 Edition, *Petroleum Refinery Piping*, American Society of Mechanical Engineers, Fairfield, New Jersey

ASME B31 1, 1996 Edition, *Chemical Plant and Petroleum Refinery Piping*, American Society of Mechanical Engineers, Fairfield, New Jersey

ASME B16, 1996 Edition, *Fittings, Flanges, and Valves*, American Society of Mechanical Engineers, Fairfield, New Jersey

ASME B16 9, 1996 Edition, *Factory Made Wrought Steel Butt Welding Fittings*, American Society of Mechanical Engineers, Fairfield, New Jersey

ASTM D-3843, *Practice for Quality Assurance for Protective Coatings Applied to Nuclear Facilities*, ASTM, Philadelphia, Pennsylvania

ASTM D-3912, *Test Method for Chemical Resistance of Coatings Used in Light Water Nuclear Power Plants*, ASTM, Philadelphia, Pennsylvania

ASTM D-4256, *Test Method for Determination of the Decontaminability of Coatings Used in Light Water Nuclear Power Plants*, ASTM, Philadelphia, Pennsylvania

ASTM D-5130, *Specification for Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants*, ASTM, Philadelphia, Pennsylvania

ASTM D-5139, *Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants*, ASTM, Philadelphia, Pennsylvania

ASTM D-5144, *Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants*, ASTM, Philadelphia, Pennsylvania

Certa, P J, 1996, *Preliminary Low-Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-210, Rev 0, Westinghouse Hanford Company, Richland, Washington

Certa, P J, W H Grams, C M McConville L W Shelton, and E J Slaathaug, 1996, *Low Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-224, Rev 0, Westinghouse Hanford Company, Richland, Washington

DOE, 1988, *Radioactive Waste Management*, DOE 5820 2A, U S Department of Energy, Washington, D C

DOE, 1989, *Safety Analysis and Review Systems*, DOE 5481 1B, U S Department of Energy, Washington, D C

DOE, 1989, *General Design Criteria*, DOE 6430 1A, U S Department of Energy, Washington, D C

DOE, 1992, *Radiological Protection for Occupational Workers*, DOE 5480 11, U S Department of Energy, Washington, D C

DOE, 1990, *General Environmental Protection Program Requirements*, DOE 5400 1, U S Department of Energy, Washington, D C

DOE-RL, 1996, *TWRS Privatization Request for Proposal* Solicitation Number DE-RP06-96RL13308 *(February 1996) U S Department of Energy* - Richland Operation Office, Richland, Washington

Evens, R A, 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Rev 0, Westinghouse Hanford Company, Richland, Washington

Fowler, K D, 1995a, *Data Quality Objectives for Tank Farm Waste Compatibility*, WHC-SD-WM-DQO-001, Rev 1, Westinghouse Hanford Company, Richland, Washington

Fowler, K D, 1995b, *Tank Farm Waste Transfer Compatibility Program*, WHC-SD-WM-OCD-015, Rev 1, Westinghouse Hanford Company, Richland, Washington

Galbraith, J D , T B Salzano (ICF KH), and J R Nicholson (ICF KH), 1996, *Decision Document for Phase I Privatization Transfer System Needs*, WHC-SD-WM-TI-750, Rev 0, Westinghouse Hanford Company, Richland, Washington

Grumbly, T P , 1996, *Proceed with privatization of Hanford tank waste treatment by consulting with regulators, the Hanford Advisory Board, and other stakeholders and to establish a full-time DOE task force to carry out the necessary procurement steps to implement privatization*, letter to the Department of Energy Secretary, U S Department of Energy, Washington, D C

KEH, 1996, *Hanford A/E Standards, Architectural/Civil GCLOAD-01, Design Loads for Facilities*, KEH-MA-22, Kaiser Engineers Hanford, Richland, Washington

Milliken, N J , 1993, *Double Shell Tank Interim Safety Equipment List*, WHC-SD-WM-SEL-026, Rev 1, Westinghouse Hanford Company, Richland, Washington

NACE, 1985, *Control of External Corrosion on Metallic Buried, Partial Buried or Submerged Liquid Storage Systems*, NACE 02-RP-85, National Association of Corrosion Engineers

Smith, G L , 1994, *Hanford Site Tank Farm Facilities Interim Safety Basis*, WHC-SD-WM-ISB-001, Rev 0, Westinghouse Hanford Company, Richland, Washington

UCRL 15910, *Design and Evaluation Guidelines for Department of Energy Facilities to Natural Phenomena Hazards*, Lawrence Livermore National Laboratory, Livermore, California

WAC 173-303, *Washington Dangerous Waste Regulations*, Washington Administrative Code, as ammended

WAC 173-360, *Underground Storage Tank Regulations*, Washington Administrative Code, as ammended

Wagenblast, G R , 1993, *Design Loads for New Underground Double Shell Tanks and Associated Underground Process Piping*, WHC-SD-GN-DGS-30008, Rev 0, Westinghouse Hanford Company, Richland, Washington

WHC, 1992, *Non-Reactor Facility Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington

WHC, 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Westinghouse Hanford Company, Richland, Washington

WHC, 1995, *WHC Occupational ALARA Program*, WHC-IP-1043, Westinghouse Hanford Company, Richland, Washington.

WHC, 1996, *Environmental Compliance*, WHC-CM-7-5, Westinghouse Hanford Company, Richland, Washington.

D7.0 FIGURES

Figure D7-1 AP Tank Farm Site Layout Option 1

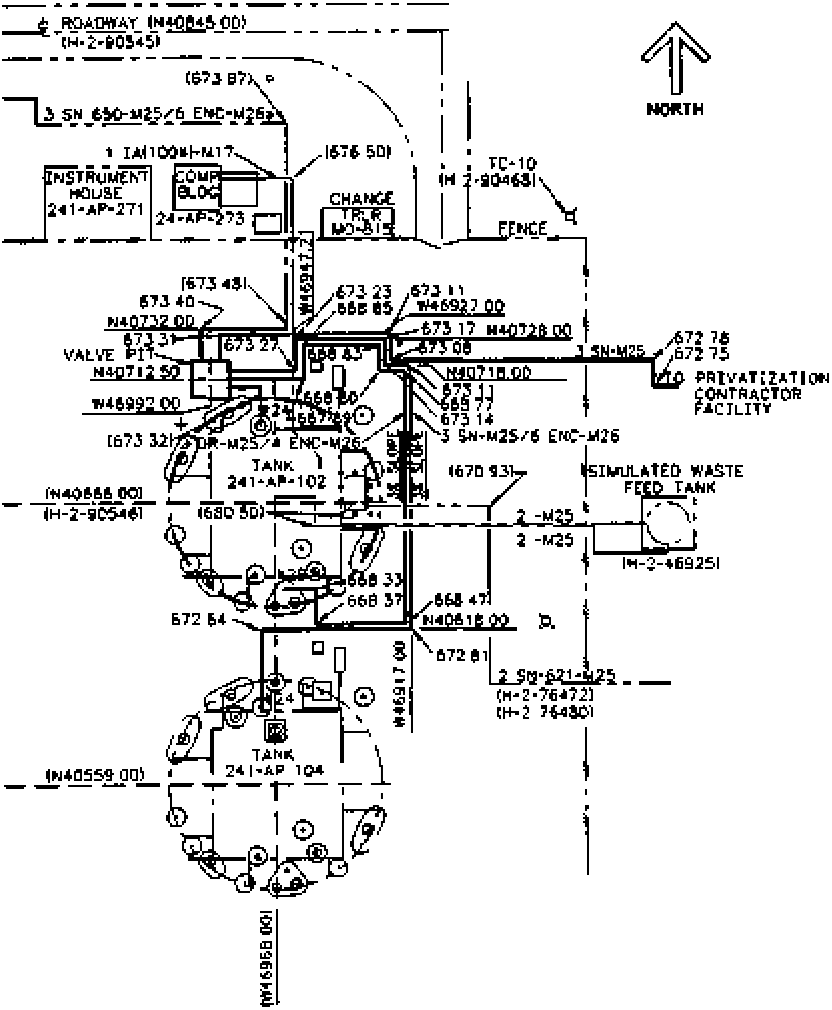


Figure D7-2. Piping and Instrumentation Diagram: Option 1.

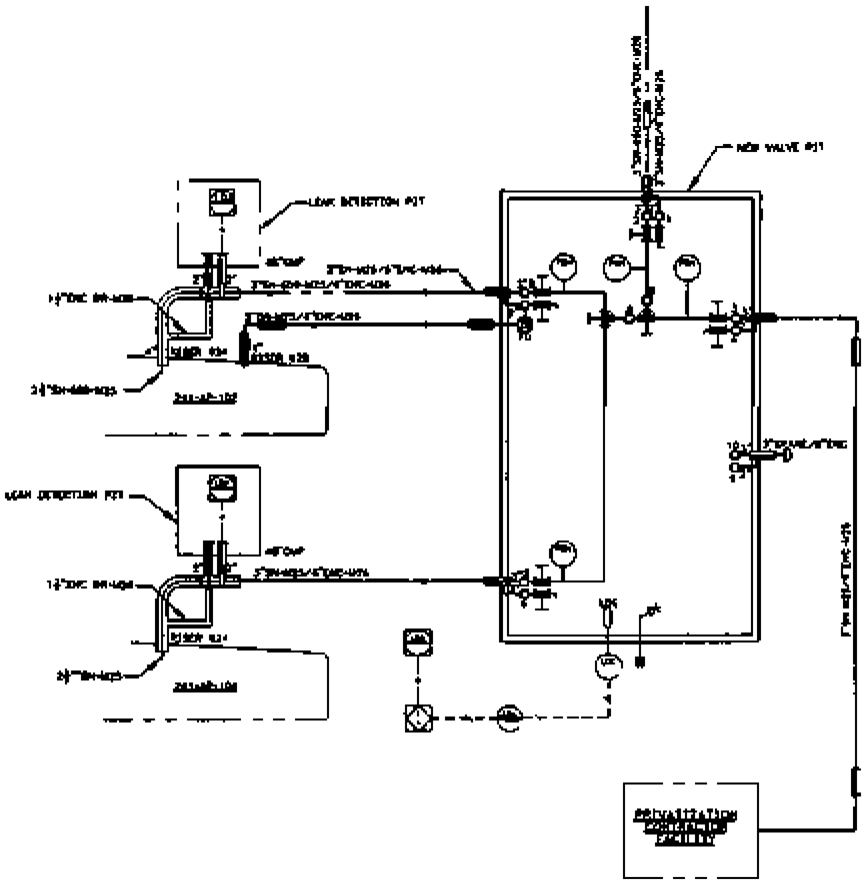


Figure D7-3. Valve Pit Jumper Arrangement: Option 1.

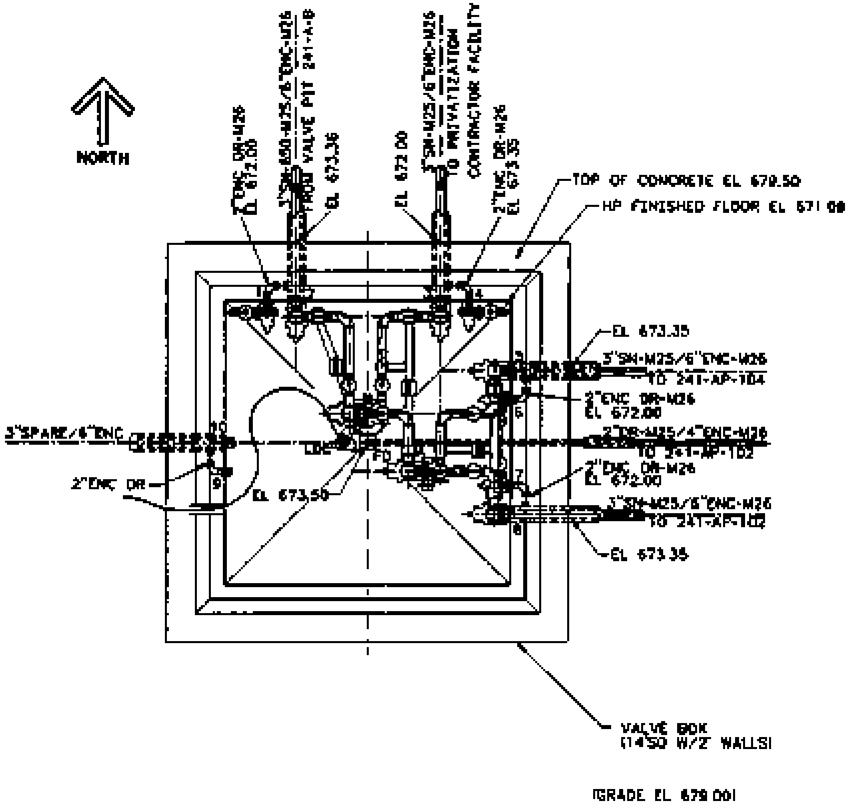
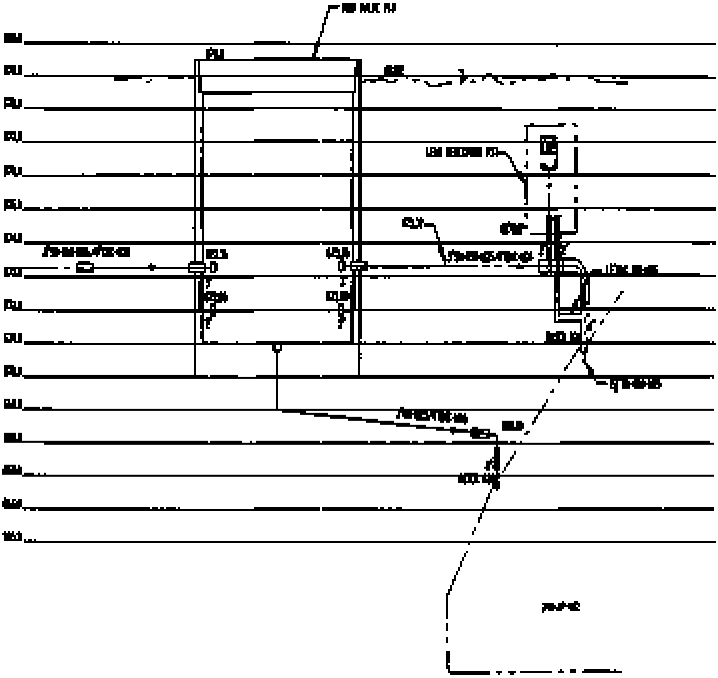
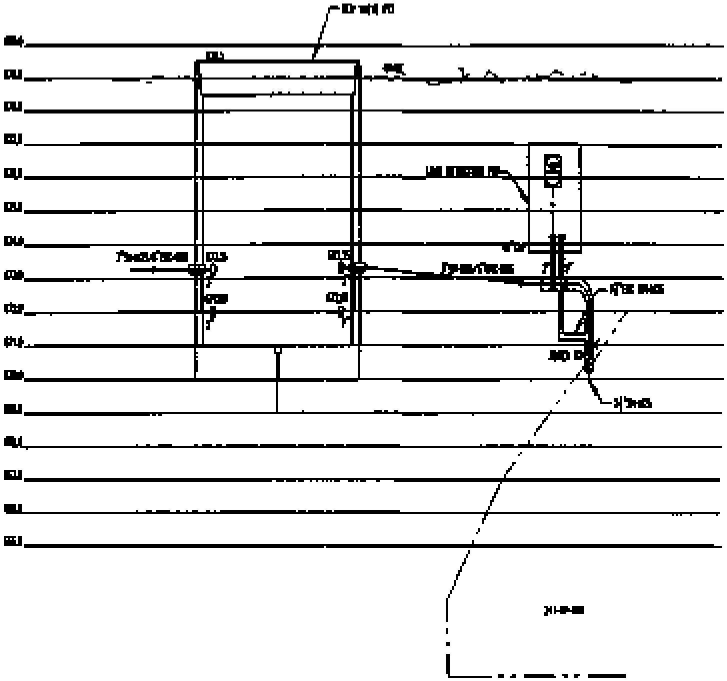


Figure D7-4. Valve Pit to Tank 241-AP-102 Hydraulic Diagram: Option 1.



COPY

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



COPY

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

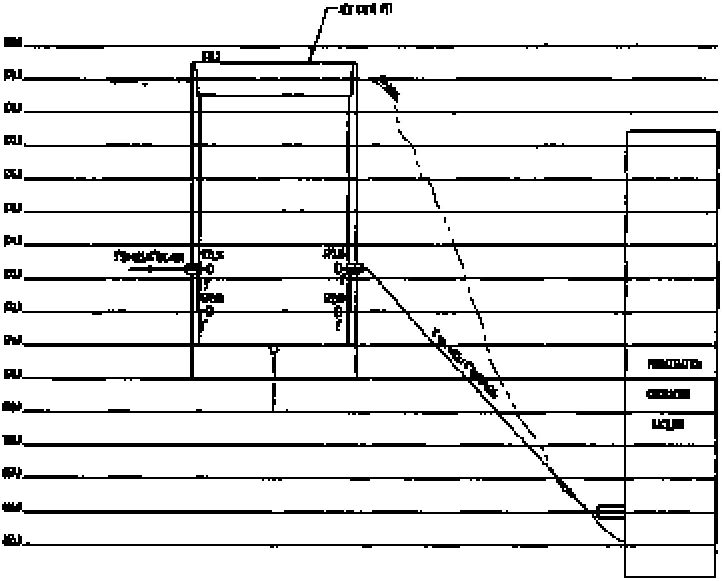


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Figure D7-7 AP Tank Farm Site Layout Option 2

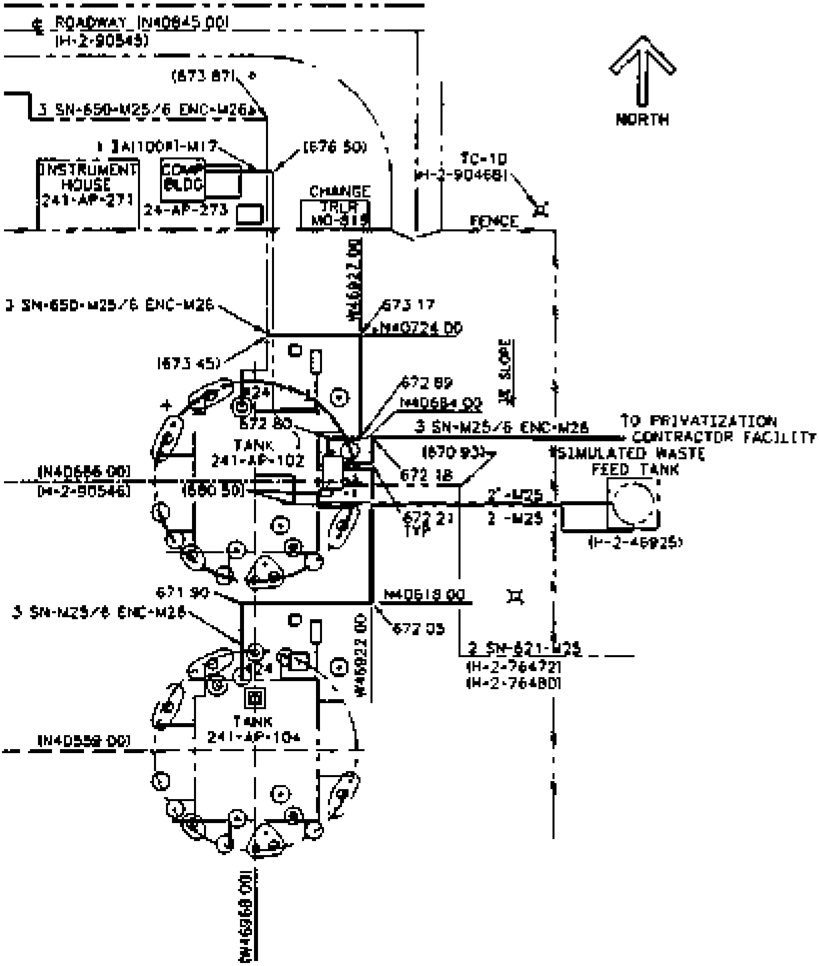

Figure D7-8. Piping and Instrumentation Diagram: Option 2.

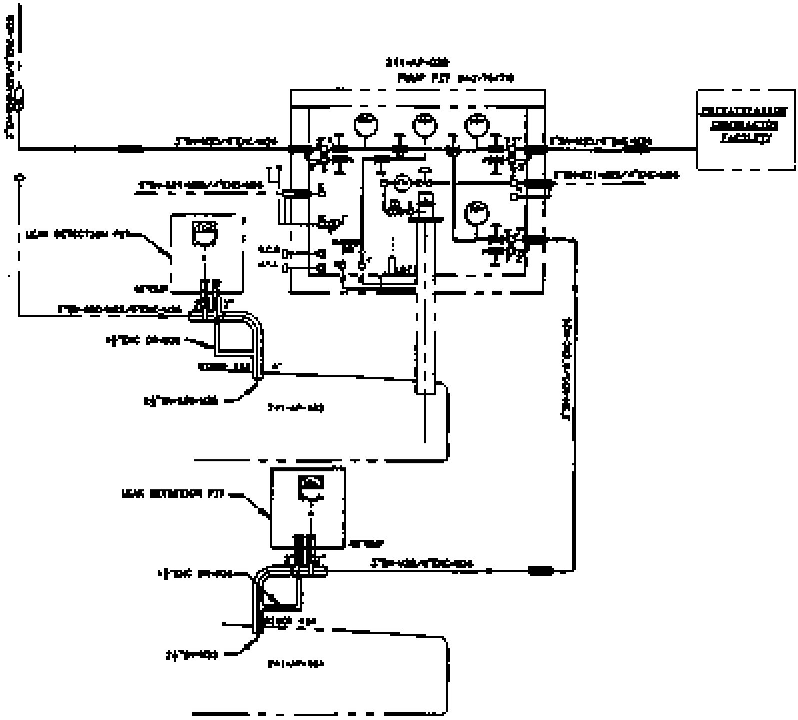

Figure D7-9. Pump Pit Jumper Arrangement: Option 2.

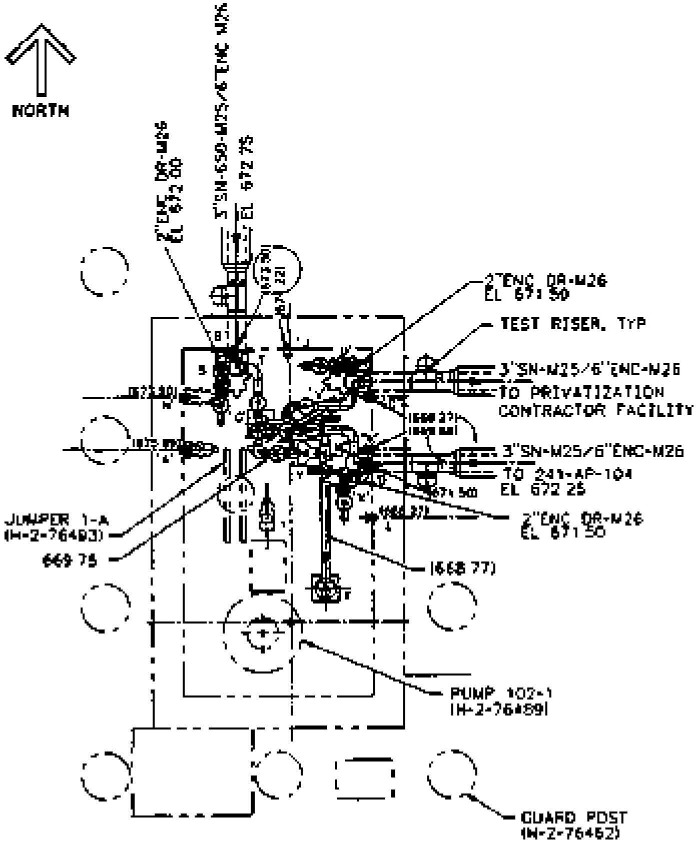

Figure D7-10. Pump Pit to Tanks 241-AP-102 and 241--104 Hydraulic Diagram: Option 2.

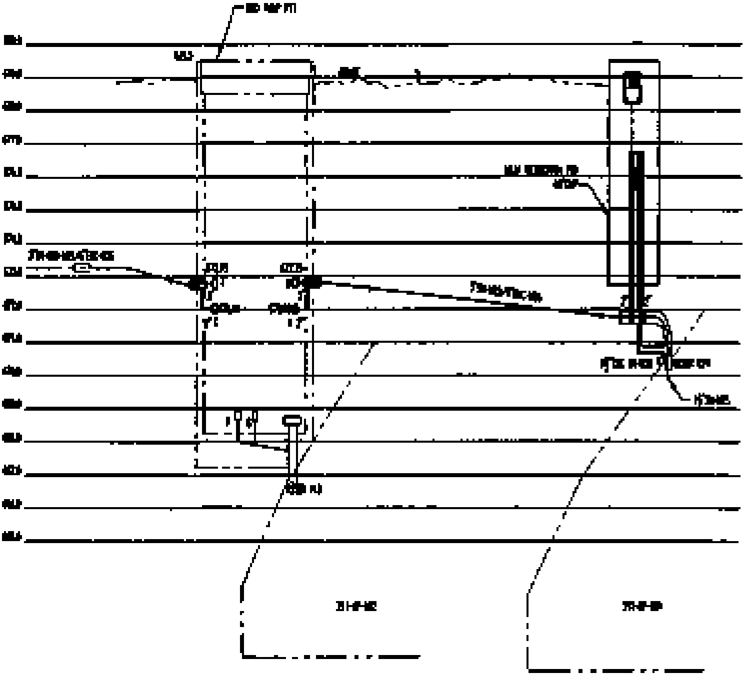

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Figure D7-11. High-Level Waste Transfer Line Hydraulic Diagram: Option 2

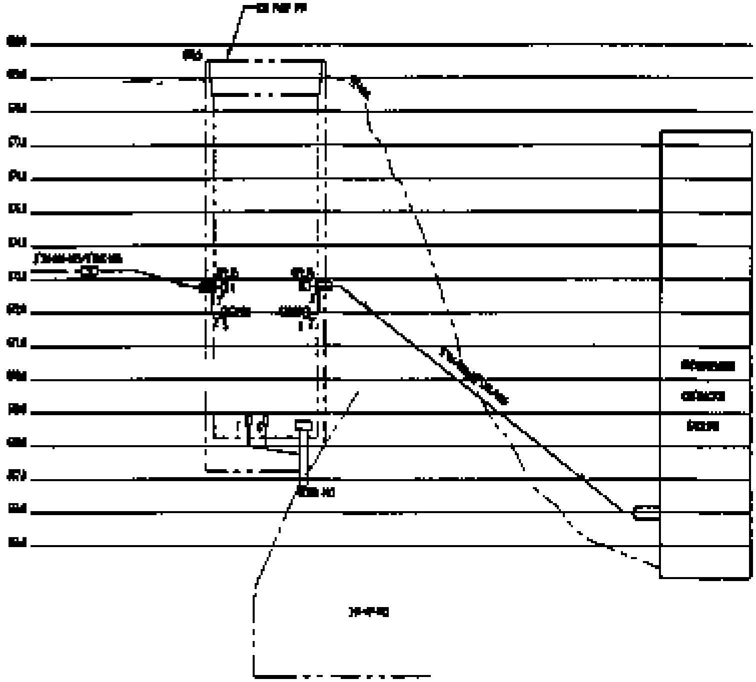

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Figure D7-12 AP Tank Farm Site Layout: Option 3.

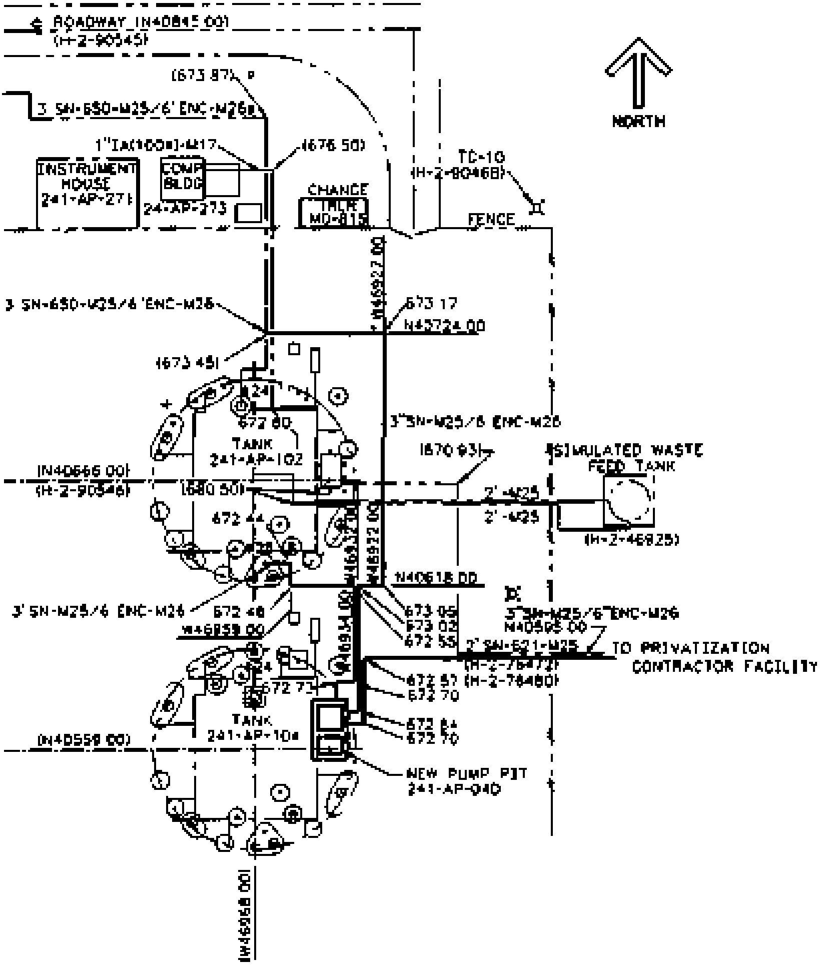

Figure D7-13 Piping and Instrumentation Diagram Option 3

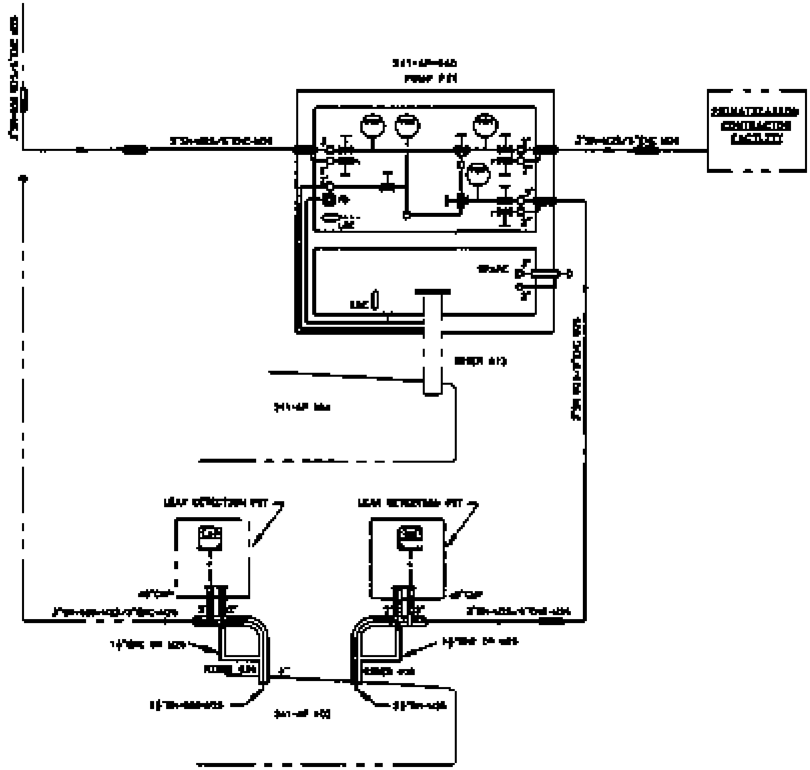

Figure D7-14. New Process Pit Jumper Arrangement: Option 3.

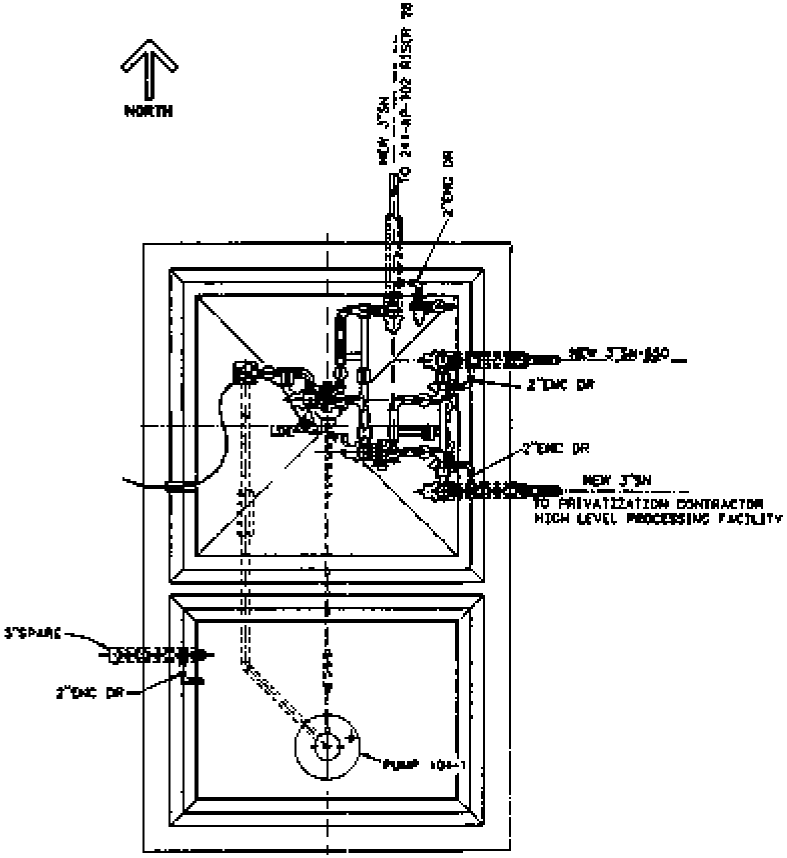

Figure D7-15. New Process Pit to Tanks 241-AP-102 and 241-AP-104 Hydraulic Diagram: Option 3.

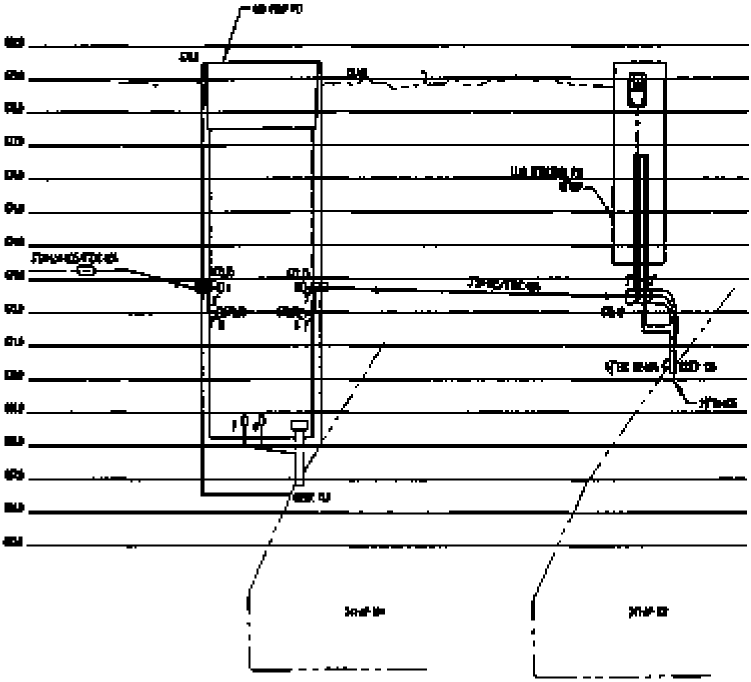

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Figure D7-16. High-Level Waste Transfer Line Hydraulic Diagram: Option 3.

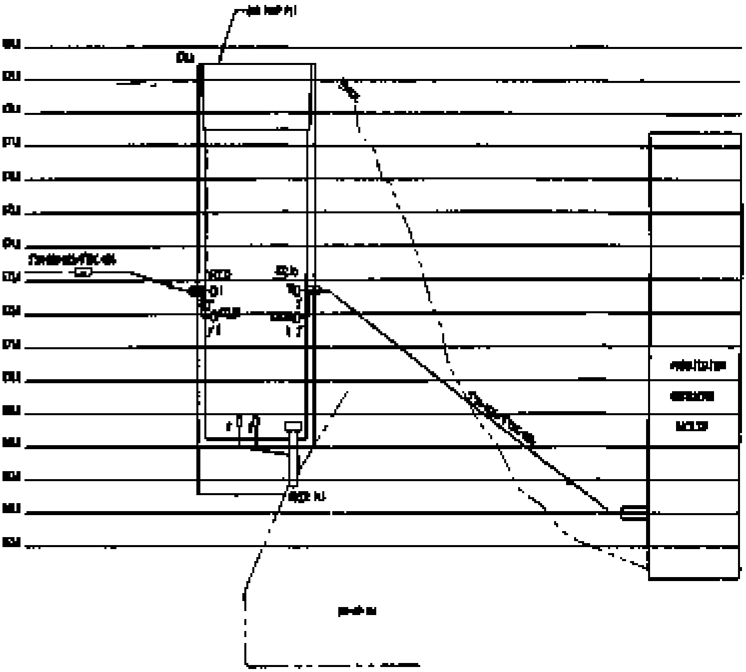

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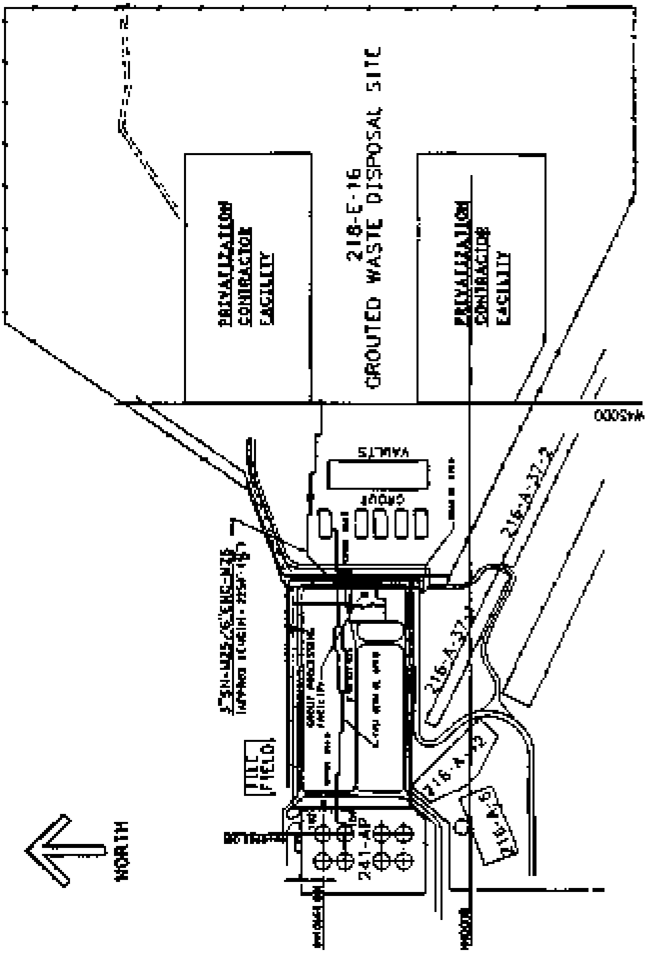
Figure D7-17. High-Level Waste Transfer Line Site Layout.



D8.0 COST ESTIMATES

D9.1 OPTION 1 COST ESTIMATE

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** ICES - INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104
UPGRADES OPT 2B STUDY ESTIMATE
RPT_001 - PROJECT COST SUMMARY

PAGE 1 OF 1
DATE 08/13/96 13:39:[illegible]
BY [illegible]

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
020	TITLE II	230,000	20	50,000	280,000
030	TITLE III	100,000	25	30,000	130,000
040	WHC PROJECT MGMT	60,000	20	10,000	70,000
	(ADJUSTED TO MEET DOE 5100.4)	10,000		10,000	20,000
TOTAL DESIGN & MANAGEMENT (D&M)		400,000		100,000	500,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	1,090,000	30	320,000	1,410,000
810	DEMOLITION	40,000	30	10,000	50,000
	(ADJUSTED TO MEET DOE 5100.4)	-30,000		-30,000	-60,000
TOTAL CONSTRUCTION COST		1,100,000		300,000	1,400,000
TOTAL ESTIMATED COST (TEC)		1,500,000		400,000	1,900,000

TYPE OF ESTIMATE	STUDY	AUGUST 13, 1996
ARCHITECT ENGINEER	Theresa Peterson	
OPERATING CONTRACTOR		

REMARKS:

THIS OPTION USES THE EXISTING PUMP PIT INSTEAD OF BUILDING A NEW ONE. NO ESCALATION IS INCLUDED.

(NUMBERS/ADJUSTED TO THE NEAREST * 10,000 / 100,000 * - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** ICES - INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104
OPERABLE OPT #2 STUDY ESTIMATE
WBS_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE OF
DATE 08/13/96 13:30:10
BY [illegible]

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
110001	DEFINITIVE DESIGN	225000	0	225000	0.00	0	225000	20	45000	270000
120001	ENG/INSPECTION	101000	0	101000	0.00	0	101000	25	25250	126250
	SUBTOTAL 1 ENGINEERING	326000	0	326000	0.00	0	326000	22	70250	396250
310001	SUPPORT FUNCTIONS/ PRECONSTRUCTION	363350	0	363350	0.00	0	363350	30	109005	472355
310006	PIPING IN THE AP FARM	578282	0	578282	0.00	0	578282	30	173485	751767
310007	JUMPERS (FAB & INSTALL)	70637	0	70637	0.00	0	70637	29	20582	91219
310009	ENV LEAK DET. & PORTION OF SN650	41113	0	41113	0.00	0	41113	30	12334	53447
310014	ELECTRICAL	72772	0	72772	0.00	0	72772	25	18194	90966
	SUBTOTAL 31 PR CONST-ONSITE E/C	1126154	0	1126154	0.00	0	1126154	30	333600	1459754
330000	EXISTING PIPE BURIAL CHARGES	3381	0	3381	0.00	0	3381	30	1014	4395
	SUBTOTAL 33 CONSTRUCTION-O/E	3381	0	3381	0.00	0	3381	30	1014	4395
	SUBTOTAL 3 CONSTRUCTION	1129535	0	1129535	0.00	0	1129535	30	334614	1464149
410001	PROJECT MGMT & INTEGRATION	56000	0	56000	0.00	0	56000	20	11200	67200
	SUBTOTAL 4 PROJECT INTEGRATION	56000	0	56000	0.00	0	56000	20	11200	67200
	PROJECT TOTAL	1,511,535	0	1,511,535	0.00	0	1,511,535	28	416,064	1,927,599

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** ICAS - INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES [illegible]
UPGRADES ALT #2 [illegible] ORDER ESTIMATE
[illegible] - ESTIMATE BASIS SHEET

PAGE 3 OF 8
DATE [illegible]
BY [illegible]

1. DOCUMENTS AND DRAWINGS

DRAWINGS: SKETCHES (NO DWG. NO.S) BY [illegible] FOR ALTS.1, 2, 3 .

2. MATERIAL PRICES

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES

A.) ICF-KH HOURLY RATES ARE BASED ON THE 1995 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE [illegible]), SEE ALSO THE FY 1996 PLANNING RATES * (REPORT [illegible]).

B.) WHC HOURLY RATES ARE BASED UPON THE FY 1996 PLANNING RATES * (REPORT [illegible]).

C.) UNIT CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE [illegible]). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE [illegible]).

* SEE HANFORD SITE REPORTING, FOR BUDGET GUIDELINE HANDBOOK, SECTION 2 - COMPANY INFORMATION, FY 1996 PLANNING RATES.

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS, TECHNICAL SERVICES AND CRAFT OVERHEAD COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE BASED ON THE ICF-KH ESTIMATING FACTOR, REVISION 1, 1995, DATED [illegible] THE TOTAL COMPOSITE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS [illegible] FOR SHOP AND FIELD WORK, WHICH IS REFLECTED IN THE "[illegible]" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION

ESCALATION WAS NOT INCLUDED.

6. ROUNDING

U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-32 SUBPARAGRAPH (H), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS (GPP'S) AND LINE ITEM (LI) COST ESTIMATES, REFERENCE: DOE 5100.4, FIGURE I-11, DATED 10-31-84.

7. REMARKS

A.) NO ESCALATION IS INCLUDED IN THIS ESTIMATE.

B.) ALL WORK BY ICF-KEH CONSTRUCTION FORCES (CF).

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** ICES - INTERACTIVE ESTIMATING **
PHASE 1 PRIVATIZATION ALTERNATIVES AP [illegible]
UPGRADES ALT #2 STUDY ESTIMATE
BOE_AP3 - ESTIMATE BASIS SHEET

PAGE 4 OF 5
DATE 08/13/96
BY [illegible]

C.) PIPE:
N-25 IS SCH 40 CSTL, 100% X-RAY & HYDRO REQUIRED
N-26 IS SCH 40 CSTL, HYDRO ONLY
AT THE [illegible] THE 6" N-26 IS INCREASED TO 8" PIPE SIZE
NO HEAT TRACE REQUIRED.
NO INSULATION AND NO EXPANSION JOINTS REQUIRED AT [illegible]
NO CROSS COUNTRY LINE IS INCLUDED IN THIS ALTERNATE.

D.) JUMPERS:
THE JUMPERS WILL ALL BE CARBON STEEL (PAINTED).

E.) EXCAVATION:
EXCAVATION MANPOWER ARE BASED ON SHOVELED EXCAVATION INSIDE THE FARM AT 5.5 MH/ CY.
WE WILL REUSE EXISTING EXCAVATED DIRT (DON'T SPECIAL BURY IT).

F.) EXISTING GRADE INSIDE THE AP FARM IS [illegible].

G.) RADIATION CONDITIONS:
NO MASK REQUIRED IN PITS EXCEPT FOR CORE DRILLING. [illegible]
WHITES REQUIRED FOR EXCAVATION IN THE FARM. MASK FOR TIE-INS TO
AND CUTTING OF EXISTING PIPE.
EXISTING EXCAVATED DIRT WILL BE REUSED - NOT BURIED.

H.) NO PUMPS OR ASSOCIATED JUMPERS ARE INCLUDED IN THIS ESTIMATE.
DIRECTIONS PER [illegible]

I.) ESTIMATE DOES NOT INCLUDE DECONTAMINATION OR REMOVING ANY EXISTING PIPE OR JUMPERS IN PITS.

J.) COSTS FOR DEFINITIVE DESIGN, [illegible]/INSPECTION AND WHC PROJECT MANAGEMENT ARE BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION.
- 18% FOR DD
- 9% FOR [illegible]
- 5% FOR WHC PM

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ICF KAISER HANFORD                        ** ICE - INTERACTIVE ESTIMATING **               PAGE      OF
WESTINGHOUSE HANFORD COMPANY         PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104        DATE  08/13/96 13:50:16
JOB NO. [illegible]                        UPGRADES  OPT #2     STUDY ESTIMATE              BY    SMP/LGN/LVB/RCH
FILE NO. EA1534R3                          RPT_R06 - COST CODE ACCOUNT SUMMARY

COST                                            ESTIMATE   ONSITE       SUB      ESCALATION       SUB       CONTINGENCY       TOTAL
CODE/WBS          DESCRIPTION                   SUBTOTAL  INDIRECTS    TOTAL     %     TOTAL     TOTAL      %     TOTAL      DOLLARS
----------------------------------------------  --------  ---------  ---------  ------ -------  ---------  ----- ---------  ---------

020  TITLE II

110005   DEFINITIVE DESIGN                       225000          0     225000   0.00       0     225000   20      45000     270000

   TOTAL 020    TITLE II                         225000          0     225000   0.00       0     225000   20      45000     270000

050  TITLE III

120001   ENG/INSPECTION                          101000          0     101000   0.00       0     101000   25      25250     126250

   TOTAL 050    TITLE III                        101000          0     101000   0.00       0     101000   25      25250     126250

060  WHC PROJECT MGMT

610001   PROJECT MGMT & INTEGRATION               56000          0      56000   0.00       0      56000   20      11200      67200

   TOTAL 060    WHC PROJECT MGMT                  56000          0      56000   0.00       0      56000   20      11200      67200

700  SPECIAL EQUIP/PROCESS SYSTEMS

310005   SUPPORT FUNCTIONS/ ENGINEERING          363350          0     363350   0.00       0     363350   30     109005     472355
310006   PIPING IN THE AP FARM                   578282          0     578282   0.00       0     578282   30     173485     751767
310007   JUMPERS  (FAB & INSTALL)                 70637          0      70637   0.00       0      70637   29      20582      91219
310016   ELECTRICAL                               72772          0      72772   0.00       0      72772   25      18172      90944

   TOTAL 700    SPECIAL EQUIP/PROCESS SYSTEM    1085041          0    1085041   0.00       0    1085041   30     321244    1406285

810  DEMOLITION

310009   DRY LEAK DET. & PORTION OF 200E          41113          0      41113   0.00       0      41113   30      12334      53447
310010   EXISTING PIPE BURIAL CHANGES              3381          0       3381   0.00       0       3381   30       1014       4395

   TOTAL 810    DEMOLITION                        44494          0      44494   0.00       0      44494   30      13348      57842

                                                =========================================================================================
PROJECT TOTAL                                                 0                            0                       416,042
                                              1,511,535             1,511,535   0.00           1,511,535   28              1,927,577
```

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ICF KAISER HANFORD                           ** ICES - INTERACTIVE ESTIMATING **                 PAGE      OF
WESTINGHOUSE HANFORD COMPANY             PHASE I PRIVATIZATION ALTERNATIVES AP102 & 106          DATE  08/13/96 13:50:23
JOB NO. P0P00F                               UPGRADED  OPT #2      STUDY ESTIMATE                BY    SMF/LGD/LRB/WCH
FILE NO. L6153AB3                          DOE_R05 - ESTIMATE SUMMARY BY CSI DIVISION

                                               ESTIMATE    ONSITE       SUB       ESCALATION        AMP      CONTINGENCY      TOTAL
 CSI   DESCRIPTION                             SUBTOTAL  INDIRECTS     TOTAL     %     TOTAL       TOTAL     %    TOTAL      DOLLARS
------ --------------------------------------  --------  ---------  ---------  ------ ---------  ---------  ----- ---------  ---------

CONSTRUCTION

 00    TECHNICAL SERVICES                        382000          0     382000   0.00          0     382000   21     81458     463658
 01    GENERAL REQUIREMENTS                      363350          0     363350   0.00          0     363350   30    109005     472355
 02    SITEWORK                                  362880          0     362880   0.00          0     362880   30    108864     471694
 09    FINISHES                                     835          0        835   0.00          0        835   30       251       1086
 15    MECHANICAL                                317695          0     317695   0.00          0     317695   30     95309     413004
 16    ELECTRICAL                                 84967          0      84967   0.00          0      84967   25     21243     106210

  TOTAL CONSTRUCTION                                             0                            0                    416,044
                                              1,511,535              1,511,535   0.00              1,511,535   28             1,927,579

                                               ==========================================================================================
PROJECT TOTAL                                                    0                            0                    416,044
                                              1,511,535              1,511,535   0.00              1,511,535   28             1,927,579
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ICF KAISER HANFORD                     ** ICES - INTERACTIVE ESTIMATING **                PAGE  7  OF  8
WESTINGHOUSE HANFORD COMPANY        PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104        DATE  05/23/96
JOB NO. P4P40F                         UPGRADES  ALT #2       STUDY ESTIMATE              BY    [illegible]
FILE NO. 24152A02                    WBS_RUG - CONTINGENCY ANALYSIS BASIS SHEET


        REFERENCE:    ESTIMATE BASIS SHEET                                 PAGE  3 OF 8
                      COST CODE ACCOUNT SUMMARY                            PAGE  5 OF 8


              THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.2 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"
        DATED 3-27-95, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE
        SHOULD HAVE AN OVERALL RANGE OF  20  TO 30% .

        CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE
        LEVEL OF THE DETAILED COST ESTIMATE.


          DESIGN & MANAGEMENT

           020 TITLE II
            WBS 310001        AN AVERAGE CONTINGENCY OF 23% WAS APPLIED TO DEFINITIVE DESIGN AND CM/INSPECTION AS THESE COSTS
                              ARE A PERCENTAGE OF DIRECT CONSTRUCTION AND A DETAILED PLANNING EFFORT FOR THIS WORK AS WELL AS
           030 TITLE III      ADDITIONAL SURVEY REQUIREMENTS FOR THE JUMPERS AND PIT NOZZLES COULD IMPACT THE PLANNED COSTS.
            WBS 120001

           040 WHC PROJECT MANAGEMENT    A 20% CONTINGENCY WAS APPLIED TO WHC PROJECT MGMT TO ALLOW FOR ADDED COST DUE ADDITIONAL
            WBS 410001                   DOCUMENTATION REQUIRED TO SUPPORT THIS UPGRADE OR ANY DELAYS IN SCHEDULE.


          CONSTRUCTION

550  OTHER STRUCTURES
310004   PIT FAB W/NEW PIPING CHANGES           30%  CONTINGENCY ADDED -LACKING DETAIL, DESIGN & FAB. CONDITIONS COULD CHANGE
   TOTAL 550    OTHER STRUCTURES                30


700  SPECIAL EQUIP/PROCESS SYSTEMS
310001   SUPPORT FUNCTIONS/ HOUSEKEEPING        30   CONTINGENCY ADDED AT SAME RATE AS CONSTRUCTION
310004   PIPING IN THE AP FARM                  30   CONTINGENCY ADDED -RADIATION OR CONTAMINATION COULD CAUSE COSTS TO RISE
310007   JUMPERS  (FAB & INSTALL)               30   CONTINGENCY ADDED +LACKING DETAIL, A CHANGE IN MATERIAL OR DESIGN IS PROBABLE
310074   ELECTRICAL                             25   CONTINGENCY ADDED -QUANTITY AND TYPE COULD CHANGE AS DETAILS WERE AVAILABLE
   TOTAL 700    SPECIAL EQUIP/PROCESS SYSTEM    29

810  DEMOLITION
310006   ENV LEAK DET. & PORTION OF DRAIN       30   CONTINGENCY ADDED -RADIATION OR CONTAMINATION COULD CAUSE COSTS TO RISE
310008   EXISTING PIPE BURIAL CHANGES           30          DITTO
   TOTAL 810    DEMOLITION                      30


                         AVERAGE CONSTRUCTION CONTINGENCY    30%


                         AVERAGE PROJECT CONTINGENCY         28%
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ICF KAISER HANFORD                   ** [illegible] - INTERACTIVE ESTIMATING **                 PAGE      OF
WESTINGHOUSE HANFORD COMPANY    PHASE I PRIVATIZATION ALTERNATIVES AP102 & 106                   DATE  [illegible]/96 13:30:25
JOB NO. [illegible]                    UPGRADES  ALT #2      STUDY ESTIMATE                          BY    [illegible]
FILE NO. [illegible]                 WBS_[illegible] - ONSITE INDIRECT COSTS BY WBS

                                                      ESTIMATE     CONTRACT ADMINISTRATION    BID PACK      OTHER       TOTAL
WBS    DESCRIPTION                                    SUBTOTAL         %         TOTAL         PREP.     INDIRECTS   INDIRECTS
------ ----------------------------------------       --------     ------    ---------    ---------    ---------   ---------

110001 DEFINITIVE DESIGN                               835994        0.00           0            0            0           0
120001 QA/INSPECTION                                   701009        0.00           0            0            0           0
310001 SUPPORT FUNCTIONS/ [illegible]                  543350        0.00           0            0            0           0
310004 PIPING IN THE AP FARM                           578282        0.00           0            0            0           0
310007 JUMPERS  (FAB & INSTALL)                         74437        0.00           0            0            0           0
310009 ANY LEAK DET. & PORTION OF ENG30                 47173        0.00           0            0            0           0
310016 ELECTRICAL                                       72771        0.00           0            0            0           0
350000 EXISTING PIPE SPECIAL CHARGES                     3381        0.00           0            0            0           0
410001 PROJECT MGMT & INTEGRATION                       56000        0.00           0            0            0           0

                                                ----------------------------------------------------------------------------------------
PROJECT TOTAL                                       1,5[illegible],5[illegible]                        0                          0
                                                                                         0                          0
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D8.2 OPTION 2 COST ESTIMATE

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ICF KAISER HANFORD                     ** ICHE - INTERACTIVE ESTIMATING **             PAGE  1  OF  [illegible]
WESTINGHOUSE HANFORD COMPANY     PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104        DATE  08/13/96 [illegible]
JOB NO. [illegible]                     [illegible]        [illegible] ESTIMATE        BY    [illegible]
FILE NO. [illegible]                   [illegible] - PROJECT COST SUMMARY

COST                                                    ESCALATED      CONTINGENCY          TOTAL
CODE     DESCRIPTION                                    TOTAL COST     %        TOTAL      DOLLARS
-----    -----------------------------------------     -----------   -----  -----------  -----------

020      TITLE II                                          340,000     20        70,000      410,000
030      TITLE III                                         130,000     27        40,000      170,000
040      WHC PROJECT MANAGEMENT                             84,000     20        20,000      100,000
          (ADJUSTED TO MEET WHC 5100.4)                     30,000              -30,000            0
                                                       ------------------------------------------------
TOTAL DESIGN & MANAGEMENT    (EDIA)                        600,000              100,000      700,000

530      OTHER STRUCTURES                                  270,000     30        80,000      300,000
700      SPECIAL EQUIP/PROCESS SYSTEMS                   1,390,000     30       430,000    1,800,000
          (ADJUSTED TO MEET WHC 5100.4)                     20,000                    0       20,000
                                                       ------------------------------------------------
TOTAL CONSTRUCTION COST                                  1,700,000              500,000    2,200,000

TOTAL ESTIMATED CONSTRUCTION COST  (TECC)                2,300,000     26       600,000    2,900,000
```

TYPE OF ESTIMATE	[illegible]	AUGUST 13, 1996
ARCHITECT ENGINEER		Thomas Peterson
OPERATING CONTRACTOR		

REMARKS:

THIS ALTERNATE INCLUDES A NEW VALVE PIT.
NO ESCALATION IS INCLUDED.

(ROUNDED/ADJUSTED TO THE NEAREST * 10,000 / 100,000 * - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

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ICF KAISER HANFORD                          ** ICE - INTERACTIVE ESTIMATING **               PAGE  2  OF  8
WESTINGHOUSE HANFORD COMPANY             PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104      DATE  06/13/96 13:13:51
JOB NO. [illegible]                          UPGRADES  OPT #1      STUDY ESTIMATE             BY    [illegible]
FILE NO. [illegible]                       WBS_002 - WORK BREAKDOWN STRUCTURE SUMMARY

                                             ESTIMATE   ONSITE       SUB       ESCALATION          EDC     CONTINGENCY        TOTAL
 WBS    DESCRIPTION                          SUBTOTAL  INDIRECTS    TOTAL      %     TOTAL        TOTAL    %     TOTAL        DOLLARS
------ -----------------------------------  --------  ---------  ---------  ------ ---------  --------- ----- ---------  ---------

110001 DEFINITIVE DESIGN                       338000          0     338000    0.00         0     338000   20      67600     405600
120001 QA/INSPECTION                           132000          0     132000    0.00         0     132000   25      33000     165000

  SUBTOTAL 1      ENGINEERING                  470000          0     470000    0.00         0     470000   22     100600     570600

310001 SUPPORT FUNCTIONS/ GREENHOUSING         344374          0     344374    0.00         0     344374   30     103312     447686
310005 PIT FAB W/OUT PIPING JUMPERS            292914          0     292914    0.00         0     292914   30      87873     380787
310006 PIPING IN THE AP FARM                   905744          0     905744    0.00         0     905744   30     271728    1177472
310007 JUMPERS  (FAB & INSTALL)                 68500          0      68500    0.00         0      68500   29      19710      88210
310010 ELECTRICAL                               74453          0      74453    0.00         0      74453   26      19114      93567

  SUBTOTAL 31     AP CONST-ONSITE C/C         1687849          0    1687849    0.00         0    1687849   30     501922    2189771

  SUBTOTAL 3      CONSTRUCTION                1687849          0    1687849    0.00         0    1687849   30     501922    2189771

410001 PROJECT MGMT. & INTEGRATION              84000          0      84000    0.00         0      84000   17      14000      98000

  SUBTOTAL 4      PROJECT INTEGRATION           84000          0      84000    0.00         0      84000   17      14000      98000

                                            ==========================================================================================
PROJECT TOTAL                                                 0                                 0                  616,522
                                           2,241,849             2,241,849    0.00             2,241,849   28                2,858,371
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1. DOCUMENTS AND DRAWINGS

DRAWINGS: SKETCHES (NO DWG. NO.S; BY W. [illegible]) FOR ALTS.1, 2, 3 .

2. MATERIAL PRICES

UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES

A.) ICF-KH HOURLY RATES ARE BASED ON THE 1995 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE (EFFECTIVE 03-08-96). SEE ALSO THE FY 1996 PLANNING RATES * (REPORT [illegible]).
B.) WHC HOURLY RATES ARE BASED UPON THE FY 1996 PLANNING RATES * (REPORT [illegible]).
C.) BASE CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-95). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 06-06-95).
* SEE HANFORD COST REPORTING, FY BUDGET GUIDELINE HANDBOOK, SECTION 2 - COMPANY INFORMATION, FY 1996 PLANNING RATES.

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS

A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS, TECHNICAL SERVICES AND CRAFT OVERHEAD COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE BASED ON THE ICF-KH ESTIMATING FACTOR, REVISION 1, FY95, DATED 1/18/96. THE TOTAL COMPOSITE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS 52% FOR SHOP WORK AND FIELD WORK, WHICH IS REFLECTED IN THE "PROF/OSI" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION

ESCALATION WAS NOT INCLUDED.

6. ROUNDING

U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE 1-32 SUBPARAGRAPH (H), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS (GPP'S) AND LINE ITEM (LI) COST ESTIMATES. REFERENCE: DOE 5100.4, FIGURE 1-11, DATED 10-31-84.

7. REMARKS

A.) NO ESCALATION IS INCLUDED IN THIS ESTIMATE.

B.) ALL WORK BY ICF-KEH CONSTRUCTION FORCES (CF).

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C.) PIPE:
    N-23 IS SCH 40 CSTL,  100% X-RAY & HYDRO REQUIRED
    N-26 IS SCH 40 CSTL,  HYDRO ONLY
    AT THE RISER FOR 4" N-26 IS INCREASED TO 6" PIPE SIZE
    NO HEAT TRACE REQUIRED.
    NO INSULATION AND NO EXPANSION VOID REQUIRED AT BENDS
    NO CROSS COUNTRY LINE IS INCLUDED IN THIS ALTERNATE.

D.) JUMPERS:
    THE JUMPERS WILL ALL BE CARBON STEEL (PAINTED), PUMP JUMPERS N.I.C.
    FOR JUMPERS IN THE NEW PUMP PIT LOOK AT THE PLAN OF THE OLD PUMP PIT
    02B - THEY WILL BE SIMILAR IN SIZE & NUMBER.

E.) EXCAVATION:
    EXCAVATION MANHOURS ARE BASED ON CAREFUL EXCAVATION INSIDE THE FARM (5.5 MHS /CY).
    WE WILL REUSE EXISTING EXCAVATED DIRT (DON'T SPECIAL HAUL IT).

F.) PITS:
    EXISTING GRADE INSIDE THE AP FARM IS 679.
    THE NEW VALVE PIT WILL HAVE A 1' THK FLOOR.  FINISH FLOOR ELEVATION
    WILL BE 671.  IT WILL BE LINED WITH 12 GUAGE SST.

G.) RADIATION CONDITIONS:
    NO MASK REQUIRED IN PITS EXCEPT FOR COREDRILLING.  NO [illegible].
    WHITES REQUIRED FOR EXCAVATION IN THE FARM.  MASK FOR TIE-INS TO
    AND CUTTING OF EXISTING PIPE.
    EXISTING EXCAVATED DIRT WILL BE REUSED - NOT BURIED.

H.) NO PUMPS OR ASSOCIATED JUMPERS ARE INCLUDED IN THIS ESTIMATE.
    DIRECTIONS PER J. PETERSON & W. LICKUNE.

I.) ESTIMATE DOES NOT INCLUDE DECONTAMINATION OR REMOVING ANY EXISTING PIPE OR JUMPERS IN PITS.

J.) COSTS FOR DEFINITIVE DESIGN, CM/INSPECTION AND WHC PROJECT MANAGEMENT ARE BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION,
    - 20% FOR DD
    -  9% FOR CMI
    -  5% FOR WHC PM
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ICF KAISER HANFORD                        ** TEST - INTERACTIVE ESTIMATING **                    PAGE  5  OF  5
WESTINGHOUSE HANFORD COMPANY          PHASE 1 PRIVATIZATION ALTERNATIVES AP102 & 104            DATE  08/13/96 13:13:53
JOB NO. [illegible]                        UPGRADES  OPT #1        STUDY ESTIMATE                BY    WHF/[illegible]
FILE NO. 24156AA3                          DOE_004 - COST CODE ACCOUNT SUMMARY

COST                                           ESTIMATE    ONSITE       SUB        ESCALATION        SUB       CONTINGENCY        TOTAL
CODE/WBS           DESCRIPTION                 SUBTOTAL   INDIRECTS    TOTAL      %      TOTAL      TOTAL      %     TOTAL       DOLLARS
---------------------------------------------  --------  ----------  ---------  ------ ---------  ---------  ----- ----------  ----------

020  TITLE II

110001   DEFINITIVE DESIGN                       238000           0     238000    0.00         0     238000   20        47600      285600

   TOTAL 020     TITLE II                        238000           0     238000    0.00         0     238000   20        47600      285600

030  TITLE III

120001   ENG/INSPECTION                          152000           0     152000    0.00         0     152000   25        38000      190000

   TOTAL 030     TITLE III                       152000           0     152000    0.00         0     152000   25        38000      190000

040  WHC PROJECT MANAGEMENT

410001   PROJECT MGMT. & INTEGRATION              84000           0      84000    0.00         0      84000   20        16800      100800

   TOTAL 040     WHC PROJECT MANAGEMENT           84000           0      84000    0.00         0      84000   20        16800      100800

550  OTHER STRUCTURES

310005   PIT FAB W/OUT PIPING SHIELD             292914           0     292914    0.00         0     292914   30        87875      380789

   TOTAL 550     OTHER STRUCTURES                292914           0     292914    0.00         0     292914   30        87875      380789

700  SPECIAL EQUIP/PROCESS SYSTEMS

310001   SUPPORT STRUCTURE/ REINFORCING          344374           0     344374    0.00         0     344374   30       103312      447686
310006   PIPING IN THE AP FARM                   905748           0     905748    0.00         0     905748   30       271724     1177472
310007   JUMPERS  (FAB & INSTALL)                 68360           0      68360    0.00         0      68360   29        19898       88258
310016   ELECTRICAL                               76453           0      76453    0.00         0      76453   25        19114       95567

   TOTAL 700     SPECIAL EQUIP/PROCESS SYSTEM   1394935           0    1394935    0.00         0    1394935   30       414047     1808982

                                               ****************************************************************************************
PROJECT TOTAL                                                     0                            0                        604,322
                                              2,161,849              2,161,849    0.00              2,161,849   28                 2,766,171
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ICF KAISER HANFORD                          ** ICES - INTERACTIVE ESTIMATING **                PAGE  1  OF  1
WESTINGHOUSE HANFORD COMPANY            PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104         DATE  08/13/96 13:13:56
JOB NO. [illegible]                         [illegible]   OPT #[illegible]      STUDY ESTIMATE          BY    [illegible]
FILE NO. [illegible]                        ODE_005 - ESTIMATE SUMMARY BY CSI DIVISION

                                               ESTIMATE    OFFSITE       SUB        ESCALATION        SUB      CONTINGENCY       TOTAL
 CSI   DESCRIPTION                             SUBTOTAL   INDIRECTS     TOTAL      %     TOTAL       TOTAL    %     TOTAL       DOLLARS
------ ------------------------------------   ---------  ----------  ---------- ------ ---------- ---------- ----- ---------  ---------

CONSTRUCTION

  00   TECHNICAL SERVICES                        574000          0      574000   0.00          0     574000   21     122640     696640
  01   GENERAL REQUIREMENTS                      344374          0      344374   0.00          0     344374   30     103312     447686
  02   SITEWORK                                  446270          0      446270   0.00          0     446270   30     133881     580151
  03   CONCRETE                                  121234          0      121234   0.00          0     121234   30      36370     157604
  05   METALS                                    116431          0      116431   0.00          0     116431   30      34929     151360
  09   FINISHES                                    7217          0        7217   0.00          0       7217   30       2165       9382
  15   MECHANICAL                                543675          0      543675   0.00          0     543675   30     163102     706777
  16   ELECTRICAL                                 88648          0       88648   0.00          0      88648   25      22163     110811

   TOTAL CONSTRUCTION                                           0                             0                     624,322
                                              2,241,849            2,241,849   0.00             2,241,849   28                2,866,171

                                              ----------------------------------------------------------------------------------------
PROJECT TOTAL                                                   0                             0                     624,322
                                              2,241,849            2,241,849   0.00             2,241,849   28                2,866,171
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ICF KAISER HANFORD                          ** ICE ** - INTERACTIVE ESTIMATING **              PAGE  7  OF  8
WESTINGHOUSE HANFORD COMPANY           PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104          DATE  08/15/96
JOB NO. P6FAD7                               UPGRADES  ALT #1       STUDY ESTIMATE             BY    [illegible]
FILE NO. 26156AA3                      DOC_ADS - CONTINGENCY ANALYSIS BASIS SHEET


          REFERENCE:   ESTIMATE BASIS SHEET                                PAGE  3 OF 8
                       COST CODE ACCOUNT SUMMARY                           PAGE  5 OF 8

                THE U.S  DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.2 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"
          DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE
          SHOULD HAVE AN OVERALL RANGE OF  20  TO 30% .

          CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE
          LEVEL OF THE DETAILED COST ESTIMATE.


          DESIGN & MANAGEMENT

             B30 TITLE II
              WBS 130001      AN AVERAGE CONTINGENCY OF 32% WAS APPLIED TO DEFINITIVE DESIGN AND ENG/INSPECTION AS THESE COSTS
                              ARE A PERCENTAGE OF DIRECT CONSTRUCTION AND A DETAILED PLANNING EFFORT FOR THIS WORK AS WELL AS
             B50 TITLE III    ADDITIONAL SURVEY REQUIREMENTS FOR THE JUMPERS AND PIT NOZZLES COULD IMPACT THE PLANNED COSTS.
              WBS 120001

             B80 WHC PROJECT MANAGEMENT    A 20% CONTINGENCY WAS APPLIED TO WHC PROJECT MGMT TO ALLOW FOR ADDED COST DUE ADDITIONAL
              WBS 110001                   DOCUMENTATION REQUIRED TO SUPPORT THIS UPGRADE OR ANY DELAYS IN SCHEDULE.


          CONSTRUCTION

550  OTHER STRUCTURES

310006   PIT FAN W/OUT PIPING CHANGE            30%  CONTINGENCY ADDED -LACKING DETAIL, DESIGN & RAD. CONDITIONS COULD CHANGE


   TOTAL 550    OTHER STRUCTURES               30


700  SPECIAL EQUIP/PROCESS SYSTEMS

310001   SUPPORT FUNCTIONS/ [illegible]         30   CONTINGENCY ADDED AT SAME RATE AS CONSTRUCTION
310004   PIPING IN THE AP FARM                  30   CONTINGENCY ADDED -RADIATION CONDITIONS COULD CAUSE COSTS TO RISE
310007   JUMPERS  (FAB & INSTALL)               29   CONTINGENCY ADDED -LACKING DETAIL, A CHANGE IN MATERIAL OR DESIGN IS PROBABLE
310016   ELECTRICAL                             25   CONTINGENCY ADDED -QUANTITY AND TYPE COULD CHANGE AS DETAILS WERE AVAILABLE

   TOTAL 700    SPECIAL EQUIP/PROCESS SYSTEM   30

                                  AVERAGE CONSTRUCTION CONTINGENCY    30%

                                  AVERAGE PROJECT CONTINGENCY         28%
```

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ICF KAISER HANFORD                         ** ICES - INTERACTIVE ESTIMATING **                PAGE  1  OF  1
WESTINGHOUSE HANFORD COMPANY          PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104          DATE  05/13/96 15:13:55
JOB NO. [illegible]                         UPGRADES  OPT #1        ROUGH ESTIMATE            BY    [illegible]
FILE NO. [illegible]                      WBS_RPT - ONSITE INDIRECT COSTS BY WBS

                                                       ESTIMATE    CONTRACT ADMINISTRATION       BID PACK       OTHER        TOTAL
WBS     DESCRIPTION                                    SUBTOTAL       %          TOTAL          PREP.      INDIRECTS    INDIRECTS
------ ---------------------------------------------- --------    -----      ---------       --------    ---------    ---------

110001 DEFINITIVE DESIGN                                330000       0.00          0               0            0            0
120001 ENG/INSPECTION                                   152000       0.00          0               0            0            0
310001 SUPPORT FUNCTIONS/ WAREHOUSING                   344374       0.00          0               0            0            0
310006 PIT FAB W/OUT PIPING ENDS                        272946       0.00          0               0            0            0
310006 PIPING IN THE AP FARM                            995744       0.00          0               0            0            0
310007 JUMPERS  (FAB & INSTALL)                          40360       0.00          0               0            0            0
310011 ELECTRICAL                                        76453       0.00          0               0            0            0
410001 PROJECT MGMT. & INTEGRATION                       81400       0.00          0               0            0            0

                                                  ************************************************************************************
PROJECT TOTAL                                        2,261,947                                     0                         0
                                                                                  0                             0
```

D8.3 OPTION 3 COST ESTIMATE

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** TEST - INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES [illegible]
UPGRADES OPT #3 STUDY ESTIMATE
DOE_501 - PROJECT COST SUMMARY

PAGE 1 OF 9
DATE 08/13/96 13:55:13
BY [illegible]

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
020	TITLE II	300,000	20	60,000	360,000
030	TITLE III	140,000	21	30,000	170,000
060	WHC PROJECT MGMT	40,000	20	10,000	50,000
	(ADJUSTED TO MEET DOE 5100.4)	0		0	0
	TOTAL DESIGN & MANAGEMENT (DDM)	500,000		100,000	600,000
550	OTHER STRUCTURES	150,000	30	40,000	190,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	1,330,000	30	390,000	1,720,000
910	DEMOLITION	40,000	30	10,000	50,000
	(ADJUSTED TO MEET DOE 5100.4)	-20,000		60,000	40,000
	TOTAL CONSTRUCTION COST	1,500,000		500,000	2,000,000
	TOTAL ESTIMATED COST (TEC)	2,000,000	30	600,000	2,600,000

TYPE OF ESTIMATE	STUDY	AUGUST 13, 1996
ARCHITECT ENGINEER		
OPERATING CONTRACTOR		

REMARKS:

THIS OPTION INCLUDES A NEW PUMP PIT.
NO ESCALATION IS INCLUDED.

(ROUNDED/ADJUSTED TO THE NEAREST * 10,000 / 100,000 * - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** ICF KH - INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104
UPGRADES OPT #3   FIRST ESTIMATE
DOE_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 2 OF 7
DATE 08/15/96 13:35:16
BY [illegible]

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE CONTINGCY	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
110001	TITLE II	303000	0	303000	0.00	0	303000	20	60600	363600
120001	TITLE III	136000	0	136000	0.00	0	136000	25	34000	170000
	SUBTOTAL 1 ENGINEERING	439000	0	439000	0.00	0	439000	22	94600	533600
310001	SUPPORT FUNCTIONS/ GREENHOUSING	356540	0	356540	0.00	0	356540	30	106962	463502
310004	PIT FAB W/OUT PIPING CHNGES	147130	0	147130	0.00	0	147130	30	44139	191269
310006	PIPING IN THE AP FARM	808301	0	808301	0.00	0	808301	30	242490	1050791
310007	JUMPERS (FAB & INSTALL)	65725	0	65725	0.00	0	65725	29	19108	84833
310008	DOV LEAK DET & PORTION OF ENCASE	41113	0	41113	0.00	0	41113	30	12334	53447
310014	ELECTRICAL	96797	0	96797	0.00	0	96797	25	24200	120997
	SUBTOTAL 31 PA CONST-ONSITE O/C	1515606	0	1515606	0.00	0	1515606	30	449233	1964839
330004	EXISTING PIPE BURIAL CHARGES	3301	0	3301	0.00	0	3301	30	1014	4315
	SUBTOTAL 33 CONSTRUCTION-O/C	3301	0	3301	0.00	0	3301	30	1014	4315
	SUBTOTAL 3 CONSTRUCTION	1518907	0	1518907	0.00	0	1518907	30	450247	1969154
410001	PROJECT MGMT & INTEGRATION	76000	0	76000	0.00	0	76000	20	15200	91200
	SUBTOTAL 4 PROJECT INTEGRATION	76000	0	76000	0.00	0	76000	20	15200	91200
	PROJECT TOTAL	2,033,907	0	2,033,907	0.00	0	2,033,907	28	560,047	2,593,954

D-62

HNF-SD-TWR-AOA-001
Revision 1

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ICF KAISER HANFORD                    ** IEST - INTERACTIVE ESTIMATING **               PAGE  3  OF  4
WESTINGHOUSE HANFORD COMPANY     PHASE I PRIVATIZATION ALTERNATIVES AP102 & 106         DATE  06/13/96
JOB NO. [illegible]                      UPGRADES  ALT #3      STUDY ESTIMATE           BY    HMF/LGR/LWR/DRG
FILE NO. 2615EAC1                       DOE_R03 - ESTIMATE BASIS SHEET


1. DOCUMENTS AND DRAWINGS
   ----------------------

   DRAWINGS:  SKETCHES (NO DWG. NO.S)  BY W. [illegible] FOR ALTS.1, 2, 3 .

2. MATERIAL PRICES
   ---------------
   UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES
   -----------
   A.) ICF-KH HOURLY RATES ARE BASED ON THE 1995 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY KEH FINANCE
         (EFFECTIVE 05-08-95). SEE ALSO THE FY 1996 PLANNING RATES * (REPORT #HRD2012)
   B.) WHC HOURLY RATES ARE BASED UPON THE FY 1996 PLANNING RATES * (REPORT #HRD2001).
   C.) ONSITE CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-95). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES
       AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 06-06-95).
       *   SEE HANFORD SOFT REPORTING, THE BUDGET GUIDELINE HANDBOOK, SECTION 2 - COMPANY INFORMATION, FY 1996 PLANNING RATES.

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS
   -----------------------------------------------
   A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS, TECHNICAL SERVICES AND CRAFT OVERHEAD COSTS ARE INCLUDED AT A
       COMPOSITE PERCENTAGE BASED ON THE ICF-KH ESTIMATING FACTOR, REVISION 1, FY95, DATED 1/10/96 THE TOTAL COMPOSITE
       PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS 93% FOR SHOP AND FIELD WORK,
       WHICH IS REFLECTED IN THE "OHP/UNIT" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION
   ----------
   ESCALATION WAS NOT INCLUDED.

6. ROUNDING
   -----------------------
   U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-32 SUBPARAGRAPH (H), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS
   (GPP'S) AND LINE ITEM (LI) COST ESTIMATES. REFERENCE: DOE 5100.4, FIGURE I-17, DATED 10-31-84.

7. REMARKS
   -------
   A.) NO ESCALATION IS INCLUDED IN THIS ESTIMATE.

   B.) ALL WORK BY ICF-KEH CONSTRUCTION FORCES (CF).
```

C.) PIPE:
N-23 IS SCH 40 CSTL, 100% X-RAY & STRESS REQUIRED
N-26 IS SCH 40 CSTL, WELDS ONLY
AT THE BENDS THE 4" N-26 IS INCREASED TO 6" PIPE SIZE
NO HEAT TRACE REQUIRED.
NO INSULATION AND NO EXPANSION JOINTS REQUIRED AT BENDS
NO CROSS CONNECT LINE IS INCLUDED IN THIS ALTERNATE.

D.) JUMPERS:
THE JUMPERS WILL ALL BE CARBON STEEL (PAINTED).
FOR JUMPERS IN THE NEW PUMP PIT LOOK AT THE PLAN OF THE OLD PUMP PIT
02E - THEY WILL BE SIMILAR IN SIZE & NUMBER.

E.) EXCAVATION:
EXCAVATION MANHOURS ARE BASED ON GUZZLER EXCAVATION INSIDE THE FARM 1.5 MHS/ CY.
WE WILL REUSE EXISTING EXCAVATED DIRT (DON'T SPECIAL BURY IT).

F.) PITS:
EXISTING GRADE INSIDE THE AP FARM IS 679,
THE NEW PUMP PIT WILL HAVE 3' THICK WALLS & 1' THK FLOOR; INSIDE
DIMENSIONS OF 4' x 9' x 9' DEEP. FINISH FLOOR AT EL 673'. 3' THICK
COVER BLOCKS. IT WILL BE LINED WITH 12 GAUGE SST.

G.) RADIATION CONDITIONS:
NO MASK REQUIRED IN PITS EXCEPT FOR SURVEILLANCE. NO [illegible].
WHITES REQUIRED FOR EXCAVATION IN THE FARM. MASK FOR TIE-INS TO
AND CUTTING OF EXISTING PIPE.
EXISTING EXCAVATED DIRT WILL BE REUSED - NOT SPECIAL BURIED.

H.) NO PUMPS OR ASSOCIATED JUMPERS ARE INCLUDED IN THIS ESTIMATE.
DIRECTIONS PER T. PETERSON & W. [illegible].

I.) ESTIMATE DOES NOT INCLUDE DECONTAMINATION OR REMOVING ANY EXISTING PIPE OR JUMPERS IN PITS.

J.) COSTS FOR DEFINITIVE DESIGN, ENG/INSPECTION AND WHC PROJECT MANAGEMENT ARE BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION.
- 20% FOR DD
- 9% FOR E&I
- 5% FOR WHC PM

```
ICF KAISER HANFORD                            ** ICES - INTERACTIVE ESTIMATING **              PAGE       OF
WESTINGHOUSE HANFORD COMPANY          PHASE 1 PRIVATIZATION ALTERNATIVES AP102 & 104           DATE  06/13/96 13:35:10
JOB NO. [illegible]                           UPGRADES  OPT #3      STUDY ESTIMATE             BY    [illegible]
FILE NO. [illegible]                          B40_R05 - COST CODE ACCOUNT SUMMARY

COST                                             ESTIMATE    ADDTIL       SUB       ESCALATION        SUB     CONTINGENCY      TOTAL
CODE/WBS           DESCRIPTION                   SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL      TOTAL    %     TOTAL     DOLLARS
-------------------------------------------     --------   ---------  ---------  ------ ---------  --------- ----- ---------  ---------

020   TITLE II

110001    TITLE II                                 303000          0     303000    0.00          0     303000   20      60600     363600

   TOTAL 020     TITLE II                          303000          0     303000    0.00          0     303000   20      60600     363600

030   TITLE III

120001    TITLE III                                136000          0     136000    0.00          0     136000   25      34000     170000

   TOTAL 030     TITLE III                         136000          0     136000    0.00          0     136000   25      34000     170000

040   WHC PROJECT MGMT

470001    PROJECT MGMT & INTEGRATION                76000          0      76000    0.00          0      76000   20      15200      91200

   TOTAL 040     WHC PROJECT MGMT                   76000          0      76000    0.00          0      76000   20      15200      91200

550   OTHER STRUCTURES

310006    PIT FAB W/OUT PIPING EXCEPT              147130          0     147130    0.00          0     147130   30      44139     191269

   TOTAL 550     OTHER STRUCTURES                  147130          0     147130    0.00          0     147130   30      44139     191269

700   SPECIAL EQUIP/PROCESS SYSTEMS

310001    SUPPORT FUNCTIONS/ WAREHOUSING           356540          0     356540    0.00          0     356540   30     106962     463502
310004    PIPING IN THE AP FARM                    808301          0     808301    0.00          0     808301   30     242490    1050791
310007    JUMPERS  (FAB & INSTALL)                  65725          0      65725    0.00          0      65725   29      19108      84833
310016    ELECTRICAL                                96797          0      96797    0.00          0      96797   25      24200     120997

   TOTAL 700     SPECIAL EQUIP/PROCESS SYSTEM     1327363          0    1327363    0.00          0    1327363   30     392760    1720123

810   DEMOLITION
```

```
ICF KAISER HANFORD                              ** ICES - INTERACTIVE ESTIMATING **                    PAGE     07
WESTINGHOUSE HANFORD COMPANY           PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104                  DATE  08/13/96 13:35:10
JOB NO. [illegible]                             UPGRADES  OPT #3      STUDY ESTIMATE                   BY    [illegible]
FILE NO. [illegible]                            RPT_004 - COST CODE ACCOUNT SUMMARY

COST                                               ESTIMATE    ONSITE       SUB        ESCALATION         SUB     CONTINGENCY        TOTAL
CODE/WBS             DESCRIPTION                   SUBTOTAL   INDIRECTS     TOTAL      %     TOTAL       TOTAL    %     TOTAL       DOLLARS
---------------------------------------------      --------   ---------   ---------  ----- ---------   --------- ----- ---------   ---------

310000   RMV LEAK DET & PORTION OF [illegible]       40513          0       40513     0.00         0       40513   30       12154       52667
330000   EXISTING PIPE BURIAL CHARGES                 3381          0        3381     0.00         0        3381   30        1014        4395

   TOTAL 010    DEMOLITION                           43894          0       43894     0.00         0       43894   30       13168       57062


                                                  ------------------------------------------------------------------------------------------
PROJECT TOTAL                                                     0                            0                        560,047
                                                 2,033,987               2,033,987   0.00               2,033,987   28                 2,594,034
```

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ICF KAISER HANFORD                      ** ICES - INTERACTIVE ESTIMATING **                    PAGE      OF
WESTINGHOUSE HANFORD COMPANY     PHASE 3 STABILIZATION ALTERNATIVES [illegible] & 104          DATE  08/13/96 13:35:20
JOB NO. P4P607                          UPGRADES   ALT #3      STUDY ESTIMATE                  BY    [illegible]
FILE NO. E6153AC3                  RPT_A03 - ESTIMATE SUMMARY BY CSI DIVISION

                                             ESTIMATE    ONSITE       EOD       ESCALATION        EOE     CONTINGENCY       TOTAL
 CSI    DESCRIPTION                          SUBTOTAL   INDIRECTS    TOTAL      %     TOTAL      TOTAL    %    TOTAL       DOLLARS
------ ----------------------------------- ---------- ---------- ---------- ------ --------- ---------- ---- ---------- ----------

CONSTRUCTION

 00    TECHNICAL SERVICES                     515000          0     515000   0.00         0     515000   21     109000     624000
 01    GENERAL REQUIREMENTS                   356540          0     356540   0.00         0     356540   30     106962     463502
 02    SITEWORK                               517724          0     517724   0.00         0     517724   30     155317     673041
 03    CONCRETE                                45225          0      45225   0.00         0      45225   30      13568      58793
 05    METALS                                  73553          0      73553   0.00         0      73553   30      22066      95619
 09    FINISHES                                 3649          0       3649   0.00         0       3649   30       1095       4744
 15    MECHANICAL                             413306          0     413306   0.00         0     413306   30     123992     537298
 16    ELECTRICAL                             108992          0     108992   0.00         0     108992   25      27248     136240

  TOTAL CONSTRUCTION                                        0                               0                       560,067
                                           2,033,987             2,033,987   0.00              2,033,987   28                2,594,054

                                           ==========================================================================================
 PROJECT TOTAL                                              0                               0                       560,067
                                           2,033,987             2,033,987   0.00              2,033,987   28                2,594,054
```

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ICF KAISER HANFORD                       ** [illegible] - INTERACTIVE ESTIMATING **         PAGE  8  OF  9
WESTINGHOUSE HANFORD COMPANY       PHASE I PRIVATIZATION ALTERNATIVES AP102 & 104       DATE  [illegible]
JOB NO. [illegible]                        UPGRADES  ALT #3       STUDY ESTIMATE             BY    [illegible]
FILE NO. [illegible]                   DOE_[illegible] - CONTINGENCY ANALYSIS BASIS SHEET

          REFERENCE:   ESTIMATE BASIS SHEET                           PAGE  5 OF 6
                       COST CODE ACCOUNT SUMMARY                      PAGE  5 OF 9

               THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.2 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION"
          DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE
          SHOULD HAVE AN OVERALL RANGE OF  20  TO 30% .

          CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE
          LEVEL OF THE DETAILED COST ESTIMATE.

               DESIGN & MANAGEMENT

               020 TITLE II         AN AVERAGE CONTINGENCY OF 22% WAS APPLIED TO DEFINITIVE DESIGN AND CM/INSPECTION AS THESE COSTS
                WBS 110001          ARE A PERCENTAGE OF DIRECT CONSTRUCTION AND A DETAILED PLANNING EFFORT FOR THIS WORK AS WELL AS
               030 TITLE III        ADDITIONAL SURVEY REQUIREMENTS FOR THE JUMPERS AND PIT NOZZLES COULD IMPACT THE PLANNED COSTS.
                WBS 120001

               060 WHC PROJECT MANAGEMENT    A 20% CONTINGENCY WAS APPLIED TO WHC PROJECT MGMT TO ALLOW FOR ADDED COST DUE
                WBS 410001                   ADDITIONAL DOCUMENTATION REQUIRED TO SUPPORT THIS UPGRADE OR ANY DELAYS IN SCHEDULE.

               CONSTRUCTION
550  OTHER STRUCTURES

310004   PIT FAB W/OUT PIPING CHANGES          30%  CONTINGENCY ADDED -LACKING DETAIL, DESIGN & RAD. CONDITIONS COULD CHANGE

   TOTAL 550    OTHER STRUCTURES               30


700  SPECIAL EQUIP/PROCESS SYSTEMS

310001   SUPPORT FUNCTIONS/ WAREHOUSING        30   CONTINGENCY ADDED AT SAME RATE AS CONSTRUCTION
310006   PIPING IN THE AP FARM                 30   CONTINGENCY ADDED -RADIATION CONDITIONS COULD CAUSE COSTS TO RISE
310007   JUMPERS  (FAB & INSTALL)              30   CONTINGENCY ADDED -LACKING DETAIL, A CHANGE IN MATERIAL OR DESIGN IS PROBABLE.
310014   ELECTRICAL                            25   CONTINGENCY ADDED -QUANTITY AND SIZE COULD CHANGE AS DETAILS WERE AVAILABLE

   TOTAL 700    SPECIAL EQUIP/PROCESS SYSTEM   29

810  DEMOLITION

310005   ANY LEAK DET. & PORTION OF SHLDS      30   CONTINGENCY ADDED - RAD./ CONTAMINATION CHANGES COULD RAISE COST
330005   EXISTING PIPE BURIAL CHARGES          30                  DITTO

   TOTAL 810    DEMOLITION                     30

                         AVERAGE CONSTRUCTION CONTINGENCY    30%

                         AVERAGE PROJECT CONTINGENCY         28%
```

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. [illegible]
FILE NO. [illegible]

** TEXT + INTERACTIVE ESTIMATING **
PHASE I PRIVATIZATION ALTERNATIVES APRIL [illegible] '96
UPGRADES OPT #3   STUDY ESTIMATE
ROE_007 - ONSITE INDIRECT COSTS BY WBS

PAGE OF
DATE 04/13/96 13:34:29
BY [illegible]

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONTRACT ADMINISTRATION %	CONTRACT ADMINISTRATION TOTAL	BID PACK PREP.	OTHER INDIRECTS	TOTAL INDIRECTS
110001	TITLE II	343000	0.00	0	0	0	0
120001	TITLE III	134000	0.00	0	0	0	0
310001	SUPPORT FUNCTIONS/ DECONTAMINATION	354540	0.00	0	0	0	0
310004	PIT FAN W/OUT PIPING CHANGES	147130	0.00	0	0	0	0
310006	PIPING IN THE AP FARM	780321	0.00	0	0	0	0
310007	JUMPERS (FAB & INSTALL)	65725	0.00	0	0	0	0
310008	ENV LEAK DET & PORTION OF SNOSD	41113	0.00	0	0	0	0
310010	ELECTRICAL	94797	0.00	0	0	0	0
330001	EXISTING PIPE BURIAL CHANGES	3361	0.00	0	0	0	0
410001	PROJECT MGMT & INTEGRATION	70000	0.00	0	0	0	0
	PROJECT TOTAL	2,033,987		0	0	0	0

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APPENDIX E

PULSAIR VENTILATION ANALYSIS LETTER REPORT

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APPENDIX E

PULSAIR VENTILATION ANALYSIS LETTER REPORT

E1.0 INTRODUCTION

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

The Pulsair mixing 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 continuous 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/min

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

- Waste tank thermodynamics
- Tank head space pressure variations
- Aerosol generation and exhaust HEPA filter life

E2.0 SUMMARY, CONCLUSION, AND RECOMMENDATIONS

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

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

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 Pulsair operation Under these conditions, HEPA filter life in the ventilation exhaust system has been calculated as 2 8 years or more Installation of a pretreatment 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 wc. 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 μm 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 m^3/min [1,200 ft^3/min) were installed. The estimated total project cost of a 11.3 m^3/min (400 ft^3/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.

E3.0 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.

Aerosol generation due to Pulsair operation was assumed to be equivalent to the effect of ALCs in existing aging waste tanks. Aerosol 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 m^3/min (1,000 ft^3/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 ft x 3 ft x 6 ft) 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).

E4.0 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 Retrieval: Literature Review and Recommendations*, Letter Report, Pacific Northwest National Laboratory, Richland, Washington.

Petersen, S. R., 1996, *Energy 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

PULSAIR VENTILATION

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page 1 of 1 Date 8/7/96

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 28 HVAC WO/Job No. E23380 Calculation No. H-02
Project No. & Name TWRS PRIVATIZATION PHASE 1
Calculation Item PULSE AIR VENTILATION

These calculations apply to:
Dwg. No. Rev. No.
Dwg. No. Rev. No.
Other (Study, CDR) FST DECISION DOCUMENT Rev. No.

The status of these calculations is:

☒ Preliminary Calculations
☐ Final Calculations
☐ Check Calculations (On Calculation Dated)
☐ Void Calculation (Reason Voided)

Incorporated in Final Drawings? ☐ Yes ☒ No
This calculation verified by independent "check" calculations? ☐ Yes ☒ No

Original and Revised Calculation Approvals

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Paul Rice 8/7/96		
Checked by	8/7/96		
Approved by			
Checked Against Approved Vendor Data			

INDEX

Design Analysis Page No.	Description
1	OBJECTIVE, CRITERIA, GIVEN DATA
2	ASSUMPTIONS, REFERENCES
3	FINDINGS & CONCLUSIONS, CALCULATIONS
4 - 8	CALCULATIONS

KEH 0778.00 (06/92) GEF072

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc No H-02
Revision 0
Page No 1 of 5

Client WHC
WO/Job No E23360
Subject Pulse-Air Ventilation
Date 8/2/96 By PD Rice
Checked 8/7/96 By E [illegible]
Location 200 E, 241-AP
Revised By

1.0 OBJECTIVE

The objective of these calculations is to determine the effect of a proposed Pulse-Air waste mixing system on the ventilation system required in AP Tank Farm.
Calculations must be performed to determine the effect on:

1) Waste Tank exhaust Thermodynamics
2) Tank headspace pressure variations
3) HEPA filter Life

2.0 CRITERIA

a) DOE 6430.1A, General Design Criteria.

3.0 GIVEN DATA

a) Pulse Volume = 1 ft³ @ 80 PSIG & 60 F
b) Pulse frequency = 5 - 12 /min.
c) Primary Vent system capacity = 1170 cfm
d) Annulus Vent system capacity = 8600 cfm
e) Tank farm will consist of 6 Tanks, 2 of which would have Pulse-Air installed.
f) max. Tank radiolytic heat = 70,000 BTU/hr

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HANFORD**

DESIGN ANALYSIS

Calc No 11-02
Revision 0
Page No 2 of 3

Client WHC
WO/Job No E23380
Subject Pulse-Air Ventilation
Date 8/2/96 By P.D. Rice
Checked 8/7/96 By E. Dalpiaz
Location 200 E, 241-AP
Revised By

4.0 ASSUMPTIONS

a) Average Summer air temp. = 77°F, humidity=4

b) Tank waste vapor supression factor = 0.45

c) average Primary airflow = 195 cfm/tank

d) average Annulus airflow = 1433 cfm/tank

e) Pulse-Air & ALC systems have similar effect on ventilat.

f) HEPA filters will reach ΔP limit before dose lim

5.0 REFERENCES

1) Cramer, E.R., 1994, "Results Heat Evaporation Test to Support Heat Removal System Design," WHC-SD-W236A-ER-010, Rev. 0.

2) Crea, B.A., 1994, "Results from Evaporation Test to Support the MWTF Heat Removal Syst. Design" WHC-SD-W236A-ER-004.

3) Ligotke, M.W. et al, 1994, "Aerosol and Vapor Source Term Produced During Double-Shell Tank Waste Mobilization and Retrieval: Literature Review and Recommendations" Letter Report

4) Burchsted, C.A., 1976, "Nuclear Air Cleaning Handbook," ERDA 76-21

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc No U-02
Revision 0
Page No 3 of 5

Client WHC
Subject Pulse-Air Ventilation
WO/Job No E23310
Date 8/2/96 By P.D. Rice
Checked 8/7/96 By E Dalpiaz
Location 200E, 241-AP
Revised By

6.0 Findings and Conclusions

1) The results of the Tank thermal analysis show that use of Pulse-Air in a Tank having 70,000 Btu/hr Radiolytic heat Load will not noticeably affect solution temperature, exhaust temperature, or water evaporation rate. The calculated solution temperature is 104 °F

2) The result of the Tank vapor space pressure variation analysis is that the variation should be less than 0.04 in.WC., which is considered negligeable.

3) The result of the aerosol generation analysis predicts a HEPA filter life time exceeding 2.8 years.

7.0 CALCULATIONS

7.1 Waste Tank Exhaust Thermodynamics

Pulse volume = 1 ft³ @ 80 psig & 60 °F

$PV = nRT$; $V_2 = \frac{P_1 V_1}{P_2}$ @ $T \cong$ Const.

$V_2 = \left(\frac{80+14.7}{14.7}\right)(1\ ft^3) = 6.4\ ft^3$

Pulse frequency = 5-12 pulses/min.

Average flow @ max. frequency = (12)(6.4) = 77 scfm

The effect of operation with & w/o Pulse air is shown on the computer print out (pgs 4 & 5):

Operation without pulse air 4/8

Pump Heat = 0 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 Depth = 10.5 ft
Concrete Depth = 1.25 ft Outside Air Temp = 77 F

Soln Temp. F	Soln vp mm Hg	Annulus Loss Btu/h	Conduct Loss Btu/h	Net Evap lbH2O/h	Exit Hum Ra lbw/lbda	Required Flow scfm	Va Exit Cond F /	%RH	Ann. Ex. Temp F	
110.0	36.2	47817.	11327.	8.01	0.031	76.78	107.7	58.3	107.4	
109.5	35.7	47052.	11186.	8.66	0.030	85.12	107.1	58.2	106.9	
109.0	36.2	46288.	11045.	9.31	0.030	93.82	106.6	58.1	106.4	
108.5	34.7	45524.	10904.	9.96	0.029	102.91	106.0	58.0	105.9	
108.0	34.2	44760.	10762.	10.60	0.029	112.41	105.5	57.9	105.4	
107.5	33.7	43997.	10621.	11.25	0.028	122.34	104.9	57.8	104.9	
107.0	33.2	43234.	10479.	11.89	0.028	132.73	104.4	57.7	104.5	
106.5	32.7	42472.	10338.	12.52	0.027	143.60	103.9	57.6	104.0	
106.0	32.3	41710.	10196.	13.16	0.027	154.99	103.3	57.4	103.5	
105.5	31.8	40948.	10055.	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 cfm
104.0	30.4	38666.	9629.	15.67	0.025	206.29	101.1	56.9	101.6	
103.5	30.0	37906.	9488.	16.30	0.024	220.74	100.6	56.8	101.1	
103.0	29.6	37147.	9346.	16.92	0.024	235.94	100.0	56.7	100.6	
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	56.4	99.6	
101.5	28.2	34873.	8920.	18.77	0.022	286.51	98.4	56.2	99.2	
101.0	27.8	34116.	8779.	19.38	0.022	305.23	97.9	56.1	98.7	
100.5	27.4	33359.	8637.	19.99	0.022	325.00	97.3	55.9	98.2	
100.0	27.0	32604.	8495.	20.60	0.021	345.89	96.8	55.7	97.7	
99.5	26.6	31849.	8353.	21.21	0.021	368.00	96.2	55.6	97.2	
99.0	26.2	31094.	8212.	21.82	0.020	391.44	95.7	55.4	96.8	
98.5	25.8	30340.	8070.	22.42	0.020	416.30	95.1	55.2	96.3	
98.0	25.4	29587.	7929.	23.02	0.019	442.71	94.6	55.0	95.8	
97.5	25.0	28835.	7787.	23.63	0.019	470.81	94.0	54.8	95.3	
97.0	24.6	28083.	7646.	24.23	0.019	500.76	93.5	54.6	94.8	
96.5	24.3	27332.	7505.	24.82	0.018	532.72	92.9	54.4	94.4	
96.0	23.9	26583.	7364.	25.42	0.018	566.90	92.4	54.2	93.9	
95.5	23.5	25833.	7223.	26.02	0.017	603.51	91.9	53.9	93.4	
95.0	23.2	25085.	7082.	26.61	0.017	642.81	91.3	53.7	92.9	
94.5	22.8	24338.	6941.	27.21	0.017	686.08	90.8	53.4	92.5	
94.0	22.5	23592.	6801.	27.80	0.016	730.67	90.3	53.2	92.0	
93.5	22.1	22847.	6660.	28.40	0.016	779.94	89.7	52.9	91.5	
93.0	21.8	22102.	6520.	28.99	0.016	833.34	89.2	52.6	91.0	
92.5	21.5	21359.	6380.	29.58	0.015	891.39	88.6	52.3	90.6	
92.0	21.1	20617.	6241.	30.18	0.015	954.69	88.1	52.0	90.1	
91.5	20.8	19877.	6102.	30.77	0.015	1023.96	87.6	51.7	89.6	
91.0	20.5	19137.	5963.	31.36	0.014	1100.02	87.1	51.4	89.2	
90.5	20.2	18400.	5826.	31.96	0.014	1183.91	86.5	51.0	88.7	
90.0	19.8	17663.	5687.	32.55	0.014	1276.81	86.0	50.7	88.2	
89.5	19.5	16928.	5549.	33.14	0.013	1380.23	85.5	50.3	87.8	
89.0	19.2	16195.	5413.	33.73	0.013	1495.96	85.0	49.9	87.3	
88.5	18.9	15463.	5277.	34.33	0.013	1624.21	84.5	49.5	86.8	
88.0	18.6	14733.	5141.	34.92	0.012	1773.81	84.0	49.0	86.4	

Operation with pulse air 5/8

Pump Heat = 0 Btu/h
Inlet Air Temp = 77 F
Suppression Factor = .45
ALC Flow Rate = 77 scfm
Tank Diameter = 75 ft
Tank Thickness = 1 in
Concrete Depth = 1.25 ft

Radionuclide Heat = 70000 Btu/h
Relative Humidity = 40 %
Inlet Air Temp at Annulus = 77 F
Annulus Flow Rate = 1433 scfm
Tank Height = 36 ft
Soil Depth = 10.5 ft
Outside Air Temp = 77 F

Ann Gap = 30 in

Soln Temp. F	Soln vp mm Hg	Annulus Loss Btu/h	Conduct Loss Btu/h	Net Evap lbH2O/h	Exit Hum Ra lbw/lbda	Required Flow scfm	Va Exit Cond F /	%RH	Ann. Ex. Temp F	
109.0	35.2	46288.	11177.	9.17	0.030	14.56	107.5	56.9	106.4	
108.5	34.7	45524.	11032.	9.82	0.030	23.18	106.9	57.0	105.9	
108.0	34.2	44760.	10887.	10.46	0.029	32.14	106.3	57.1	105.4	
107.5	33.7	43997.	10742.	11.14	0.029	41.44	105.8	57.3	104.9	
107.0	33.2	43234.	10597.	11.80	0.028	51.11	105.2	57.4	104.5	
106.5	32.7	42472.	10451.	12.49	0.028	60.05	104.6	57.9	104.0	
106.0	32.3	41710.	10307.	13.12	0.028	71.03	104.1	57.8	103.5	
105.5	31.8	40948.	10164.	13.76	0.027	82.54	103.5	57.7	103.0	
105.0	31.3	40187.	10020.	14.39	0.026	94.60	103.0	57.6	102.5	
104.5	30.9	39426.	9876.	15.02	0.026	107.24	102.4	57.4	102.0	
104.0	30.4	38666.	9732.	15.65	0.025	120.51	101.8	57.3	101.6	118 cfm
103.5	30.0	37906.	9588.	16.28	0.025	134.45	101.3	57.2	101.1	
103.0	29.5	37147.	9444.	16.90	0.024	149.10	100.7	57.0	100.6	
102.5	29.1	36388.	9300.	17.52	0.024	164.51	100.2	56.9	100.1	
102.0	28.7	35630.	9156.	18.14	0.023	180.73	99.6	56.8	99.6	
101.5	28.2	34873.	9012.	18.76	0.023	197.82	99.0	56.6	99.2	
101.0	27.8	34116.	8868.	19.38	0.023	215.85	98.5	56.5	98.7	
100.5	27.4	33359.	8724.	19.99	0.022	234.87	97.9	56.3	98.2	
100.0	27.0	32604.	8581.	20.60	0.022	254.98	97.3	56.1	97.7	
99.5	26.6	31849.	8437.	21.22	0.021	276.25	96.8	56.0	97.2	
99.0	26.2	31094.	8293.	21.82	0.021	298.78	96.2	55.8	96.8	
98.5	25.8	30340.	8149.	22.43	0.020	322.68	95.7	55.6	96.3	
98.0	25.4	29587.	8006.	23.04	0.020	348.05	95.1	55.4	95.8	
97.5	25.0	28835.	7862.	23.64	0.019	376.04	94.6	55.2	95.3	
97.0	24.6	28083.	7719.	24.25	0.019	403.77	94.0	55.0	94.8	
96.5	24.3	27332.	7576.	24.85	0.019	434.43	93.4	54.8	94.4	
96.0	23.9	26583.	7433.	25.45	0.018	467.19	92.9	54.6	93.9	
95.5	23.5	25833.	7290.	26.05	0.018	502.25	92.3	54.4	93.4	
95.0	23.2	25085.	7147.	26.65	0.017	539.87	91.8	54.1	92.9	
94.5	22.8	24338.	7004.	27.25	0.017	580.29	91.2	53.9	92.5	
94.0	22.5	23592.	6862.	27.85	0.017	623.85	90.7	53.6	92.0	
93.5	22.1	22847.	6720.	28.45	0.016	670.89	90.1	53.4	91.5	
93.0	21.8	22102.	6578.	29.04	0.016	721.82	89.6	53.1	91.0	
92.5	21.5	21359.	6436.	29.64	0.016	777.13	89.0	52.8	90.6	
92.0	21.1	20617.	6295.	30.24	0.015	837.36	88.5	52.5	90.1	
91.5	20.8	19877.	6154.	30.84	0.015	903.18	88.0	52.2	89.6	
91.0	20.5	19137.	6013.	31.44	0.015	975.37	87.4	51.9	89.2	
90.5	20.2	18400.	5873.	32.03	0.014	1054.85	86.9	51.5	88.7	
90.0	19.8	17663.	5733.	32.63	0.014	1142.74	86.3	51.1	88.2	
89.5	19.5	16928.	5594.	33.23	0.013	1240.39	85.8	50.8	87.8	
89.0	19.2	16195.	5456.	33.83	0.013	1349.45	85.3	50.4	87.3	
88.5	18.9	15462.	5318.	34.43	0.013	1471.94	84.8	50.0	86.8	
88.0	18.6	14733.	5181.	35.03	0.012	1610.41	84.3	49.5	86.4	

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. H-02
Revision 0
Page No. 6 of 8

Client WHC		WO/Job No. E23380	
Subject Pulse-Air Ventilation		Date 8/5/96	By Paul Rice
		Checked 8/7/96	By E Petriak
Location 200 E, 241-AP		Revised	By

Calculations (cont)

7.2 Tank Headspace Pressure Variations

The most conservative approach is to assume the tank headspace is a sealed volume when the air pulse is added to a full tank.

$PV = nRT$; $\frac{P_2}{P_1} = \frac{n_2}{n_1}$ @ const. T & V

Head volume = Total tank volume − waste volume

Total volume of DST = 198,215 ft³

Volume of 1,000,000 gal = 133,680 ft³

∴ Head volume = 64,535 ft³

Change in n due to 1 pulse = 6.4 ft³ @ STP.

$$\therefore \frac{n_2}{n_1} = \frac{(64{,}535 + 6.4)}{(64{,}535)} = 1.000093$$

$$\therefore P_2 = (14.7\ \text{psia})(1.000093) = 14.7014\ \text{psia}$$

$$\therefore \Delta P = P_2 - P_1 = 0.0014\ \text{psi} = 0.039\ \text{in. wc.}$$

The maximum variation in tank head pressure will occur at minimum tank negative ~ 1"wc.

$$\therefore \text{Variation \%} = \frac{0.039\text{"wc}}{1\text{"wc}} \cong \underline{\underline{4\%}}\ \text{(Negligeable)}$$

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. H-02
Revision 0
Page No. 7 of 8

Client WHC
WO/Job No. E23580
Subject Pulse-Air Ventilation
Date 8/5/96 By Paul Rice
Checked 8/7/96 By E Dalpiaz
Location 200 E, 241-AP
Revised By

Calculations (Cont.)

7.3 HEPA Filter Life

Per reference 3), measured particulate concentration in the 241 AY-AZ vent header downstream of the raw water condensers and upstream of the deentrainer varied from 0.9 μg/m³ to 68 μg/m³ & averaged 16.5. The ALC flowrate from all four tanks averaged ~15%, similar to the pulse-air flow rate expected:

$$\frac{\text{Pulse air from Tanks AP 102 \& 104}}{\text{Total air flow}} = \frac{(2)(77\ \text{scfm})}{(1170\ \text{scfm})} = 13\%$$

Ref. 3) also notes that condensers in the AY-AZ ventilation system have a particle DF of approximately 1.3 to 16. ([illegible])

∴ The apparent particle concentration in the vent header near the tank outlet with ALC's operating =

$$(16.5\ \mu g/m^3)(\text{condenser DF} \approx 5) \cong 83\ \mu g/m^3$$

For comparison, Ref 3) reveals that particle measurements at AP Farm resulted in a dry aerosol concentration of 15 μg/m³ (at tank). This value was unchanged when mixer pumps were operated.

Of the data available, the most conservative estimate of aerosol concentration that could challenge the final exhaust system = 83 μg/m³

i.e. aerosol load in 1170 scfm vent. syst. flow =

$$\frac{1170\ \frac{ft^3}{min}(83\ \mu g/m^3)}{(35.3\ ft^3/m^3)} = 2735\ \mu g/min.$$

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. H-02
Revision 0
Page No. 8 of 8

Client WHC	WO/Job No. 523380
Subject Pulse-Air Ventilation	Date 8/5/96 By PD Rice
	Checked 8/7/96 By
Location 200 E, 241-AP	Revised By

Calculations (cont.)

Typical HEPA filter particulate load at changeout ≅ 2000 gm. ∴ Time to accumulate 2000 gm in HEPA filter. (assume HEPA filter takes all particulate)

$$= \frac{2000 \text{ gm}}{2.735 \times 10^{-3} \text{ gm/min}} = 731,400 \text{ min} = 508 \text{ days}$$

Per ref A), Prefilters will approximately double the HEPA filter life.

∴ HEPA filter life expected = (508)(2) = 1016 days
= 2.8 yrs

This should be considered conservative, as no credit was given for the effect of the demister in the system in removing particulate that would be encapsulated in liquid mist. Liquid would be present in the system if conduction heat losses from the single wall vent piping (underground) cooled the airflow from the tank vapor space condition of 102°F @ 57% RH to below 80°F

E7.0 COST ESTIMATE

VORTEX SCRUBBER

ICF KAISER HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. Z-4[illegible]
FILE NO. [illegible]

** ICES - INTERACTIVE ESTIMATING **
AP-102/104 PULSE AIR SYSTEM - VORTEX RECORDER INST
STUDY ESTIMATE
RPT_001 - PROJECT COST SUMMARY

PAGE 1 OF 18
DATE 08/27/96 09:54:50
BY [illegible]

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
620	TITLE II DESIGN	240,000	25	60,000	300,000
650	TITLE III E/I DURING CONSTRUCTION	100,000	25	30,000	130,000
660	PROJECT MANAGEMENT	130,000	25	40,000	170,000
	(ADJUSTED TO MEET DOE 5100.4)	30,000		-30,000	-30,000
TOTAL DESIGN AND MANAGEMENT		500,000	20	100,000	600,000
550	OTHER STRUCTURES	20,000	40	10,000	30,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	2,200,000	32	700,000	2,900,000
	(ADJUSTED TO MEET DOE 5100.4)	-20,000		-10,000	-30,000
TOTAL CONSTRUCTION		2,200,000	30	700,000	2,900,000
TOTAL ESTIMATED CONSTRUCTION COSTS (TEC)		2,700,000	30	800,000	3,500,000
900	OTHER PROJECT COSTS	400,000	25	100,000	500,000
	(ADJUSTED TO MEET DOE 5100.4)	0		0	0
TOTAL PROJECT COSTS (TPC)		3,100,000	30	900,000	4,000,000

TYPE OF ESTIMATE	STUDY ESTIMATE	AUGUST 27, 1996
ARCHITECT/ ENGINEER:		
OPERATING CONTRACTOR		

REMARKS:

[illegible] ESCALATION WAS [illegible] THIS ESTIMATE WAS PREPARED [illegible] ESCALATION PE[illegible] HAVE BEEN APPLIED TO THIS ESTIMATE.

CHECK

(ROUNDED/ADJUSTED TO THE NEAREST = 10,000 / 100,000 *) - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING

```
ICF KAISER HANFORD                              ** TEST - INTERACTIVE ESTIMATING **                    PAGE  2  OF  10
WESTINGHOUSE HANFORD COMPANY             AW 102/104 PULSE AIR SYSTEM - VORTEX SCRUBBER TEST             DATE  08/27/96 09:56:50
JOB NO. F-610                                           STUDY ESTIMATE                                  BY    GLM
FILE NO. 26105AE2                            WBS_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

                                                     ESTIMATE    ONSITE        SUB       ESCALATION         SUB     CONTINGENCY        TOTAL
 WBS   DESCRIPTION                                   SUBTOTAL   OVERHEADS     TOTAL      %      TOTAL      TOTAL     %     TOTAL      DOLLARS
------ -----------------------------------------    --------- ---------  ---------  ------ ---------  ---------- ----- ----------  ----------

111010 TITLE II DESIGN                                241660          0     241660    0.00          0     241660   25      60415      302075
121010 TITLE III A/E DURING CONSTRUCTION              103566          0     103566    0.00          0     103566   25      25892      129458

  SUBTOTAL 1      ENGINEERING                         345226          0     345226    0.00          0     345226   25      86307      431533

241010 VORTEX SCRUBBER ASSEMBLY                       599706          0     599706    0.00          0     599706   20     119941      719647
241020 VORTEX SCRUBBER HOUSING STRUCTURE               74134          0      74134    0.00          0      74134   25      18534       92668

  SUBTOTAL 2      PROCUREMENT                         673840          0     673840    0.00          0     673840   21     138475      812315

310000 GENERAL REQUIREMENTS                           172056          0     172056    0.00          0     172056   40      68821      240877
317010 SCRUBBER INSTL & HOUSING STRUCTURE              22727          0      22727    0.00          0      22727   40       9091       31818
317020 VENT & DRAIN LINE INSTALL/TIE IN               221528          0     221528    0.00          0     221528   24      52383      273911
317050 ELECTRICAL SYSTEMS                              40582          0      40582    0.00          0      40582   30      12175       52757
317050 BURNOUT                                       1068908          0    1068908    0.00          0    1068908   40     427563     1496471

  SUBTOTAL 31     CONSTRUCTION FORCES                1525801          0    1525801    0.00          0    1525801   37     570033     2095834

330000 BURIAL COSTS                                    14883          0      14883    0.00          0      14883   25       3721       18604

  SUBTOTAL 33     OPERATING CONTRACTOR                 14883          0      14883    0.00          0      14883   25       3721       18604

  SUBTOTAL 3      CONSTRUCTION                       1540684          0    1540684    0.00          0    1540684   37     573754     2114438

400000 A/E PROJECT MANAGEMENT                         149596          0     149596    0.00          0     149596   25      37399      186995

  SUBTOTAL 4      PROJECT MANAGEMENT                  149596          0     149596    0.00          0     149596   25      37399      186995

500000 OTHER PROJECT COSTS                            395820          0     395820    0.00          0     395820   25      98955      494775

                                                    ------------------------------------------------------------------------------------------
PROJECT TOTAL                                                     0                             0                       934,890
                                                   3,105,166              3,105,166   0.00              3,105,166   30               4,040,056
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ICF KAISER HANFORD                      ** ICES - INTERACTIVE ESTIMATING **               PAGE  1  OF  10
WESTINGHOUSE HANFORD COMPANY      AP-102/104 PULSE AIR SYSTEM - VORTEX SCRUBBER UNIT      DATE  08/27/96 12:45:16
JOB NO. 2-416                                  STUDY ESTIMATE                             BY    [illegible]
FILE NO. [illegible]                   BAS_RPT - ESTIMATE BASIS SHEET

1. DOCUMENTS AND DRAWINGS
   ----------------------
   DOCUMENTS: VENDOR LETTER FROM AEA TECHNOLOGY ENGINEERING SERVICES, INC, TO JOHN D GALBRAITH, DATED AUG 9, 1996.

              E-MAIL, CHARLTON ASSUMPTIONS FOR VENTILATION ESTIMATE (PULSAIR) FROM JOHN D GALBRAITH, DATED, AUG 15, 1996

   DRAWINGS: AP TANK FARM SKETCH OF UNDERGROUND UTILITIES, NO DRAWING NUMBER.

2  MATERIAL PRICES
   ---------------
   UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.  VENDOR INFORMATION WAS OBTAINED FOR THE FOLLOWING ITEMS:
   VORTEX SCRUBBER

3. LABOR RATES
   -----------
   A.) ICF KH HOURLY RATES ARE BASED ON THE 1996 FISCAL YEAR BUDGET LIQUIDATION RATES AS ISSUED BY ICF KH FINANCE
         (EFFECTIVE 1 OCT 95).  SEE ALSO THE FY 1996 PLANNING RATES * (REPORT [illegible]).
   B.) WHC HOURLY RATES ARE BASED UPON THE FY 1996 PLANNING RATES * (REPORT [illegible]).
   C.) BHI HOURLY RATES ARE BASED UPON THE FY 1996 PLANNING RATES * (REPORT [illegible]).
   D.) BASE CRAFT RATES ARE AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-95). RATES INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES,
       TRAVEL,DEPARTMENTAL OVERHEADS AND G&A/GME.
       *    THE HANFORD SOFT REPORTING, FDS BUDGET GUIDELINE HANDBOOK, SECTION E - COMPANY INFORMATION, FY 1996 PLANNING RATES.

4  GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS
   -------------------------------------------------
   A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS AND TECHNICAL SERVICES COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE
       BASED ON THE ICF KH ESTIMATING FACTORS FOUND IN SECTION 2 OF THE BUDGET GUIDELINE HANDBOOK (BGHB) LOCATED ON HANFORD SOFT
       REPORTING, FDS BUDGET GUIDELINE HANDBOOK. THE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS
       52% FOR SHOP WORK AND FIELD WORK, WHICH IS REFLECTED IN THE "GRTS/OHD" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION
   ----------
   NO ESCALATION PERCENTAGES WERE CALCULATED FOR THIS "CHECK" STUDY ESTIMATE.

6  ROUNDING
   ------------------------
   U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-32 SUBPARAGRAPH (B), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS
   (GPP'S) AND LINE ITEM (LI) COST ESTIMATES.  REFERENCE: DOE 5100.4, ISSUED [illegible], DATED 10-31-84.

7  REMARKS
   -------
   A.) THIS ESTIMATE REPRESENTS THE COST FOR THE ON-SITE A/E TO PERFORM THE ENGINEERING, E/I DURING CONSTRUCTION, PROCUREMENT,
       AND CONSTRUCTION EFFORTS, WITH THE OPERATING CONTRACTOR PROVIDING THE OVERALL PROJECT MANAGEMENT EFFORT.

   B.) DEFINITIVE DESIGN AND E/I DURING CONSTRUCTION COSTS WERE INPUT BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION AND
       PROCUREMENT COSTS LESS BURIAL FEES AND REMOVAL COSTS.

   C.) PROJECT MANAGEMENT COSTS WERE INPUT BASED ON A PERCENTAGE OF DIRECT ENGINEERING, CONSTRUCTION AND PROCUREMENT COSTS LESS
       BURIAL FEES AND REMOVAL COSTS.
```

7. REMARKS CONT.

D) OTHER PROJECT COSTS WERE INPUT BASED ON A PERCENTAGE OF DIRECT CONSTRUCTION COSTS LESS BURIAL FEES AND BURNOUT COSTS. THE PERCENTAGES FOR THESE EFFORTS WHERE DERIVED BASED ON ESTIMATED COSTS FROM PROJECT W-314.

E) POSSIBLE RADIATION DOSE RATES FOR PRIMARY VENT LINE TIE-IN, PROVIDED BY THE PROJECT ENGINEER, WHERE STATED TO BE BETWEEN 200 MR AND 500 MR. PER DIRECTION OF THE PROJECT ENGINEER THE LOWER RATE OF 200 MR WAS USED TO CALCULATE BURNOUT COSTS. BURNOUT COSTS WHERE CALCULATED SOLELY ON THIS RATE WITH NO ALLOWANCES FOR POSSIBLE DOSE REDUCING EQUIPMENT AND/OR EFFORTS

F) THE DRAIN LINE WAS ESTIMATED TO BE APPROXIMATELY 150 LF FROM THE SCRUBBER TO AN UNUSED 4" RISER IN TANK 241-AP 104

G) PER DIRECTION OF THE PROJECT ENGINEER, THE SCRUBBER UNIT HOUSING STRUCTURE HAVE BEEN ABSTRACTED FROM SIMILAR BUILDING COSTS CONTAINED IN PROJECT W-030.

H) NO COSTS HAVE BEEN INCLUDED IN THIS ESTIMATE FOR TESTING/TRAINING MOCK UPS NOR DOES IT CONTAIN ANY COSTS FOR OPERATOR TRAINING.

I) THIS ESTIMATE ASSUMES THAT ALL WORK WILL BE PERFORMED ON REGULAR SHIFTS, NO ALLOWANCE FOR OVERTIME OR PREMIUM TIME HAS BEEN INCLUDED.

J) IT IS ASSUMED THAT ELECTRICAL POWER SUPPLIES AVAILABLE IN THE TANK FARM WILL BE SUFFICIENT FOR THE NEEDS OF THIS PROJECT.

K) GUZZLER PRODUCTION AND HAND EXCAVATION RATES WHERE OBTAINED FROM PROJECT W-030.

L) THE FOLLOWING IS THE LIST OF [illegible] ASSUMPTIONS PROVIDED IN THE REFERENCED E-MAIL FROM JOHN A GALBRAITH:

ELECTRICAL SERVICE:
120 VOLT FOR SPACE HEATERS/WITH THERMO CONTROL, LIGHTS IN STRUCTURE, TRANSFER PUMP (DRAIN PUMP), AND DEMINERALIZED WATER RECIRCULATION PUMP

WATER SUPPLY:
FOR THIS ESTIMATE NO RAW WATER SUPPLY WILL BE REQUIRED SINCE THE SYSTEM WILL USE A CLOSED LOOP DEMINERALIZED WATER SYSTEM. IT IS ASSUMED THAT THE "SKID" WILL HAVE A DEMINERALIZED WATER HOLDING TANK WHICH WILL BE REFILLED AS REQUIRED TO SUPPORT THE OPERATION.

HOUSING STRUCTURE:
IT IS ASSUMED THAT A TILT UP CONCRETE STRUCTURE WILL BE CONSTRUCTED TO MEET SHIELDING REQUIREMENTS. THIS STRUCTURE WILL BE OF SIMILAR CONSTRUCTION TO THE ENCLOSED STRUCTURE PROVIDED FOR PROJECT W-030 CYCLONE. THE APPROXIMATE DIMENSIONS WILL BE 15'(L) X 8'(W) X 8'(H). THE FINAL STRUCTURE WILL BE COVERED WITH A TIN ROOF TO PROTECT THE "SKID". THE STRUCTURE WILL FITTED WITH A STAINLESS STEEL CATCH PAN WITH DRAIN, THE PAN WILL BE 6" DEEP AND EQUIPPED WITH A LEAK DETECTION SYSTEM. THE CONCRETE STRUCTURE WILL BE CONSTRUCTED WITH A LABYRINTH ENTRY AND DOOR. THE DRAIN SYSTEM FROM THE CATCH PAN AND CONDENSATE RETURN WILL BE ENCASED AND ROUTED TO AP-104; A EXISTING RISER WILL BE USED TO CONNECT THE DRAIN LINE TO THE TANK.

VENT LINE:
THE SKID MOUNTED SYSTEM WILL BE LOCATED EAST OF THE AP VENT PITS. WE WILL EXCAVATE DOWN TO THE EXISTING 12" PRIMARY VENT HEADER; APPROXIMATELY 5' BELOW GRADE; THIS WILL BE DONE IN TWO LOCATIONS. THE TIE-INS TO THE VENT HEADER WILL BE HOT TIE-INS. APPROXIMATELY 50' OF NEW 12" VENT PIPING WILL BE ADDED WITH SIX(6) 90 DEGREE LONG RADIUS ELBOWS THE VENT PIPING WILL BE COLD TAR WRAPPED AND A "HOLIDAY TEST" PERFORMED.

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ICF KAISER HANFORD                        ** ICEST - INTERACTIVE ESTIMATING **                 PAGE  5  OF  10
WESTINGHOUSE HANFORD COMPANY        AP-102/104 PULSE AIR SYSTEM - VORTEX SCRUBBER UNIT         DATE  08/27/96 09:54:57
JOB NO.  Z 416                                      STUDY ESTIMATE                             BY    BLN
FILE NO.  Z416SA02                       RAE_R04 - COST CODE ACCOUNT SUMMARY
```

COST CODE/WBS	DESCRIPTION	ESTIMATE SUBTOTAL	WBS INDIRECTS	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
020	TITLE II DESIGN									
021010	TITLE II DESIGN	241660	0	241660	0.00	0	241660	25	60415	302075
TOTAL 020	TITLE II DESIGN	241660	0	241660	0.00	0	241660	25	60415	302075
030	TITLE III E/I DURING CONSTRUCTION									
031010	TITLE III E/I DURING CONSTRUCTION	103566	0	103566	0.00	0	103566	25	25892	129458
TOTAL 030	TITLE III E/I DURING CONSTRU	103566	0	103566	0.00	0	103566	25	25892	129458
060	PROJECT MANAGEMENT									
060000	O/C PROJECT MANAGEMENT	149596	0	149596	0.00	0	149596	25	37399	186995
TOTAL 060	PROJECT MANAGEMENT	149596	0	149596	0.00	0	149596	25	37399	186995
550	OTHER STRUCTURES									
551010	SCRUBBER INSTL & HOUSING STRUCTURE	18226	0	18226	0.00	0	18226	40	7291	25517
TOTAL 550	OTHER STRUCTURES	18226	0	18226	0.00	0	18226	40	7291	25517
700	SPECIAL EQUIP/PROCESS SYSTEMS									
701010	VORTEX SCRUBBER ASSEMBLY	599706	0	599706	0.00	0	599706	30	179841	779547
701020	VORTEX SCRUBBER HOUSING STRUCTURE	74116	0	74116	0.00	0	74116	25	18531	92647
710000	GENERAL REQUIREMENTS	172016	0	172016	0.00	0	172016	40	68829	240845
711010	SCRUBBER INSTL & HOUSING STRUCTURE	4501	0	4501	0.00	0	4501	40	1800	6301
711020	VENT & DRAIN LINE INSTALL/TIE IN	241534	0	241534	0.00	0	241534	25	60383	301917
711030	ELECTRICAL SYSTEMS	40582	0	40582	0.00	0	40582	30	12175	52757
711070	CHECKOUT	1043912	0	1043912	0.00	0	1043912	40	417565	1461477
790000	RENTAL COSTS	14885	0	14885	0.00	0	14885	25	3721	18606
TOTAL 700	SPECIAL EQUIP/PROCESS SYSTEM	2190300	0	2190300	0.00	0	2190300	32	701740	2892040

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ICF KAISER HANFORD                          ** ICES - INTERACTIVE ESTIMATING **                         PAGE  8  OF  10
WESTINGHOUSE HANFORD COMPANY            AP 102/104 PULSE AIR SYSTEM - VORTEX DECEMBER 1995              DATE  04/27/96 08:54:11
JOB NO. 1-610                                      STUDY ESTIMATE                                       BY    RLM
FILE NO  24108AE7                       DOE_WBS - COST CODE ACCOUNT SUMMARY

COST                                         ESTIMATE    ONSITE       SUB      ESCALATION          SUB      CONTINGENCY/      TOTAL
CODE/WBS          DESCRIPTION                SUBTOTAL   INDIRECTS    TOTAL     %      TOTAL       TOTAL     %      TOTAL     DOLLARS
-------------------------------------------  --------  ----------  ---------  ------ ---------  ---------- ----- ----------  ---------

900   OTHER PROJECT COSTS

900000    OTHER PROJECT COSTS                  395020           0     395020   0.00          0     395020   25       98755     493775

   TOTAL 900     OTHER PROJECT COSTS           395020           0     395020   0.00          0     395020   25       98755     493775

                                             ------------------------------------------------------------------------------------------
PROJECT TOTAL                                                   0                            0                       934,092
                                            3,105,148               3,105,148  0.00                3,105,148   30               4,039,240
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ICF KAISER HANFORD                        ** ICES - INTERACTIVE ESTIMATING **                  PAGE  7  OF  10
WESTINGHOUSE HANFORD COMPANY        AP-102/104 PULSE AIR SYSTEM - VORTEX SCRUBBER UNIT        DATE  08/27/96 09:54:52
JOB NO. E-416                                     STUDY ESTIMATE                               BY    GLM
FILE NO. 3416AAEZ                    RPT_009 - ESTIMATE SUMMARY BY CSI DIVISION

                                             ESTIMATE    ONSITE        SUB        ESCALATION        SUB      CONTINGENCY        TOTAL
 CSI   DESCRIPTION                           SUBTOTAL   INDIRECTS     TOTAL       %     TOTAL      TOTAL      %     TOTAL      DOLLARS
------ ----------------------------------  --------  ---------  ---------  ------ --------  ---------  ----- ---------  ---------

CONSTRUCTION

 00   TECHNICAL SERVICES                     741064          0     741064    0.00        0     741064     25    185266     926330
 01   GENERAL REQUIREMENTS                   202234          0     202234    0.00        0     202234     40     80895     283131
 02   SITEWORK                                82175          0      82175    0.00        0      82175     27     22056     104251
 03   CONCRETE                                 7197          0       7197    0.00        0       7197     40      2879      10076
 05   METALS                                    969          0        969    0.00        0        969     40       388       1357
 15   MECHANICAL                            1881307          0    1881307    0.00        0    1881307     32    593866    2475173
 16   ELECTRICAL                              40582          0      40582    0.00        0      40582     30     12175      52757
 19   PROJECT MANAGEMENT                     149596          0     149596    0.00        0     149596     25     37399     186995

  TOTAL CONSTRUCTION                                       0                             0                         934,892
                                          3,105,140            3,105,140   0.00             3,105,140     30               4,040,032

                                          ==============================================================================================
PROJECT TOTAL                                              0                             0                         934,892
                                          3,105,140            3,105,140   0.00             3,105,140     30               4,040,032
```

REFERENCE: ESTIMATE BASIS SHEET PAGE 3 & 4 OF 10
COST CODE ACCOUNT SUMMARY PAGE 5 & 6 OF 10

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.2 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION" DATED 5-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE SHOULD HAVE AN OVERALL RANGE OF 20 TO 30 % UP TO 50 % FOR EXPERIMENTAL/SPECIAL CONDITIONS.

CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE LEVEL OF THE DETAILED COST ESTIMATE.

ENGINEERING AND MANAGEMENT PDC COST CODES 020, 030, AND 040

WBS 1.1 AND WBS 1.2 DUE TO THE DEFINITIVE DESIGN AND T/I DURING CONSTRUCTION EFFORTS BEING CALCULATED AS A PERCENTAGE OF DIRECT CONSTRUCTION AND PROCUREMENT COSTS, AN OVERALL CONTINGENCY OF 25 PERCENT HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL PLANNING/MANLOADING OF THESE EFFORTS. THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA TRACKING AVERAGE DEVIATION OF ENGINEERING COSTS VS DIRECT CONSTRUCTION AND PROCUREMENT COSTS.

WBS 4.0 DUE TO THE PROJECT MANAGEMENT EFFORTS BEING CALCULATED AS PERCENTAGE OF OTHER DIRECT COSTS (SEE THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGE METHODOLOGY), AN OVERALL CONTINGENCY OF 25 PERCENT HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL PLANNING/MANLOADING OF THIS EFFORT. THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA TRACKING AVERAGE DEVIATION OF PROJECT MANAGEMENT COSTS VS DIRECT CONSTRUCTION AND PROCUREMENT COSTS.

AVERAGE ENGINEERING CONTINGENCY 25 %

CONSTRUCTION PDC COST CODES 550 AND 700

WBS 2.0 OVERALL CONTINGENCIES OF 30 PERCENT FOR THE "SCRUBBER ASSEMBLY" PROCUREMENT AND 25 PERCENT FOR THE "SCRUBBER HOUSING STRUCTURE" PROCUREMENT WERE APPLIED BASED ON THE RELATIVE RISK OF INCREASED REQUIREMENTS FOR EACH EFFORT DUE TO THE OVERALL SCOPE BEING IN THE PRELIMINARY STAGES AT THE TIME THIS ESTIMATE WAS PREPARED.

WBS 3.1 AND WBS 3.3 PER DIRECTION OF THE PROJECT ENGINEER, OVERALL CONTINGENCIES RANGING FROM 35 TO 40 PERCENT HAVE BEEN APPLIED TO ALL CONSTRUCTION EFFORTS. THESE CONTINGENCIES WERE APPLIED TO COVER UNKNOWN COST INCREASES DUE TO THE SCOPE OF THIS PROJECT BEING IN THE STUDY/PRELIMINARY STAGES AT THIS TIME, WITH MULTIPLE UNRESOLVED ISSUES RELATED TO RADIATION DOSES AT THE PRIMARY VENT [illegible], SHIELDING (HOUSING STRUCTURE) REQUIREMENTS FOR THE SCRUBBER, AND POST [illegible] EFFORTS WHICH MAY OCCUR.

AVERAGE CONSTRUCTION CONTINGENCY 37 %

```
OTHER PROJECT COSTS  DOE COST CODE 900

  WBS 9.0      DUE TO THE OTHER PROJECT COSTS EFFORTS BEING CALCULATED AS PERCENTAGES OF OTHER DIRECT COSTS
              (SEE THE ESTIMATE DETAIL AND ESTIMATE BASIS FOR PERCENTAGE METHODOLOGY), AN OVERALL CONTINGENCY
              OF 25 PERCENT HAS BEEN APPLIED TO COVER POSSIBLE COST INCREASES WHICH MAY OCCUR DURING THE ACTUAL
              PLANNING/MANLOADING OF THESE EFFORTS. THIS CONTINGENCY WAS CALCULATED BASED ON HISTORICAL DATA
              TRACKING AVERAGE DEVIATION OF OTHER PROJECT COSTS VS DIRECT CONSTRUCTION AND PROCUREMENT COSTS.

                   AVERAGE OTHER PROJECT COSTS CONTINGENCY 25 %

                   AVERAGE PROJECT CONTINGENCY 30 %
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ICF KAISER HANFORD                        ** KEFF - INTERACTIVE ESTIMATING **                          PAGE  19  OF  19
WESTINGHOUSE HANFORD COMPANY        AP-102/105 PULSE AIR SYSTEM - VORTEX SCRUBBER TEST                 DATE  08/27/96 09:56:13
JOB NO. 2-570                                        STUDY ESTIMATE                                    BY    KLM
FILE NO. 2410EA27                       RPT_EK7 - ONSITE INDIRECT COSTS BY WBS

                                                  ESTIMATE     CONTRACT ADMINISTRATION      BID PACK       OTHER        TOTAL
WBS     DESCRIPTION                               SUBTOTAL        %        TOTAL             PREP.       INDIRECTS    INDIRECTS
------ ----------------------------------------  --------     ------   ---------         --------      ---------    ---------

110000 TITLE II DESIGN                             241640       0.00          0               0             0            0
121000 TITLE III A/E DURING CONSTRUCTION           107546       0.00          0               0             0            0
201010 VORTEX SCRUBBER ASSEMBLY                    599790       0.00          0               0             0            0
201020 VORTEX SCRUBBER HOUSING STRUCTURE            74134       0.00          0               0             0            0
310000 GENERAL REQUIREMENTS                        172056       0.00          0               0             0            0
311010 SCRUBBER INSTL & HOUSING STRUCTURE           82727       0.00          0               0             0            0
311020 VENT & DRAIN LINE INSTALL/TIE-IN            261970       0.00          0               0             0            0
311030 ELECTRICAL SYSTEMS                           40583       0.00          0               0             0            0
311050 RUNHOUT                                    1040708       0.00          0               0             0            0
330000 BURIAL COSTS                                 34885       0.00          0               0             0            0
400000 O/C PROJECT MANAGEMENT                      149578       0.00          0               0             0            0
500000 OTHER PROJECT COSTS                         775820       0.00          0               0             0            0

                                               ------------------------------------------------------------------------------------
PROJECT TOTAL                                   3,183,168                                     0                          0
                                                                            0                               0
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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

F1.1 PROJECTED FEED BATCH SUPERNATANT COMPOSITIONS

The feed batch supernatant compositional masses (as they will exist in the intermediate waste feed staging tanks) 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 transuranics (TRU) is the sum of neptunium, plutonium, and americium isotopes.

Tables F-3 and F-4 show the projected IWFST feed batch supernatant compositions[1] 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:

$$C_i^L = \frac{M_i}{MW_i * V_B} \left(10^6 \ \frac{g}{MT} \right) \qquad \text{Eqn 1}$$

where:

M_i = Mass of component *i* (excluding radionuclides) in the batch (MT)

MW_i = Molecular weight of component *i* (g/mole)

V_B = Volume of the Batch (L).

---

[1] 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 supernatant (C_r^L) were calculated with the following equation:

$$C_r^L = \frac{M_r}{V_o} \qquad \text{Eqn 2}$$

where:

M_r = Activity of radionuclide *r* in the batch (Bq).

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	C	C	C	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	C
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	[illegible]	[illegible]	[illegible]	[illegible]	C	C	C	C	C	[illegible]
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SpG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
Al(OH)4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba2+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca2+		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd2+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg2+		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La3+		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni2+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb2+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO4 2-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO4 3-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	D	C	C	D	C
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{++}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+++}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$CO_3^=$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$SO_4^=$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$PO_4^=$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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 settled 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_F^{max}) is 5 percent

- The percentage of the actual solids volume to the total volume in the compacted sludge layer ($R_{A/C}$) 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 retrieval is the dilution factor (D) and is described in Certa et al (1996) for each source tank waste retrieved

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 displays other information from Table 2-21 in Certa et al (1996) including the volume of retrieved waste, the dilution factor, and the total sludge that is thought to be layered at the bottom of the source tank The maximum permissible volume ratio of compacted sludge layer entrained to retrieved waste (R_E^{max}) was calculated using the following equation

$$R_E^{max} = R_F^{max} \frac{R_{A/S}}{R_{A/C}} D \qquad \text{Eqn 3}$$

where

R_F^{max} = Maximum permissible ratio of settled solids layer volume to feed batch vol%

$R_{A/C}$ = Percentage of actual solids volume to total volume in the compacted sludge layer (percent)

$R_{A/S}$ = Percentage of actual solids volume to total volume in the settled solids layer (percent)

D = Dilution 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_{ESL}^{max}) that can be entrained from each source tank can be calculated by the following equation

$$V_{ESL}^{max} = V_R \frac{R_E^{max}}{100\%} \qquad \text{Eqn 4}$$

where

V_R = Volume of waste retrieved 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.

Table F-5 Estimated Solids/Sludges Entrainment

Source Tanks[a]	Batch # for Contractors 1 & 2[a] (1 2)	Waste volume retrieved[a] (V_R)	Dilution ratio[a] (D)	Maximum entrainment allowed (R_E^{max})	Maximum entrained sludge layer (V_{ESL}^{max})	Total sludge in source tank[a]
AN-104	3 3	3.02 ML	1.71	6.10%	0.18 ML	1.00 ML
AW-101	4 4	3.94 ML	1.43	5.11%	0.20 ML	0.32 ML
AY-101	6,12 6	4.18 ML	1.00	3.57%	0.15 ML	0.31 ML
AN-107	7,8 7,8	3.68 ML	1.31	4.68%	0.17 ML	0.51 ML
AN-102	9 9	3.84 ML	1.62	5.78%	0.22 ML	0.34 ML
AN-106	10 10	4.00 ML	2.31	8.25%	0.33 ML	0.05 ML

[a] Data from the Certa et al. (1996)

F1.3 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., sludges) 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).

	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank Sample Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]						[illegible]			[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]									[illegible]			
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]												
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[illegible]						[illegible]			[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]				[illegible]
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[illegible]						[illegible]	[illegible]	[illegible]				[illegible]
[illegible]							[illegible]	[illegible]				
TOC						[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]									[illegible]			
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[illegible]				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			

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

	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sample Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$						[illegible]	[illegible]	[illegible]	[illegible]			
Ba^{+2}						[illegible]			[illegible]			
Ca^{+2}						[illegible]	[illegible]	[illegible]	[illegible]			
Cd^{+2}									[illegible]			
$Cr(OH)_4^-$						[illegible]	[illegible]	[illegible]	[illegible]			
Fe^{+3}						[illegible]	[illegible]	[illegible]	[illegible]			
Hg^{+2}												
K^+							[illegible]	[illegible]				
La^{+3}						[illegible]			[illegible]			
Na^+						[illegible]	[illegible]	[illegible]	[illegible]			
Ni^{+2}						[illegible]	[illegible]	[illegible]	[illegible]			
Pb^{+2}						[illegible]	[illegible]	[illegible]				
U												
CO_3^{-2} (TIC)							[illegible]	[illegible]	[illegible]			
Cl^-							[illegible]	[illegible]	[illegible]			
F^-							[illegible]	[illegible]				
SO_4^{-2}							[illegible]	[illegible]				
NO_3^-							[illegible]	[illegible]				
NO_2^-							[illegible]	[illegible]				
PO_4^{-3}						[illegible]	[illegible]	[illegible]				
OH^-							[illegible]	[illegible]				
TOC						[illegible]	[illegible]	[illegible]	[illegible]			
^{90}Sr						[illegible]	[illegible]	[illegible]	[illegible]			
^{99}Tc									[illegible]			
^{137}Cs				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
TRU				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
^{237}Np												
^{238}Pu												
^{239}Pu				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
^{240}Pu				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
^{241}Pu				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			
^{241}Am				[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			

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 50 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_i^T). These were calculated with the following equation:

$$C_i^T = C_i^L + R_F \, R_{AS} \, C_i^S \qquad \text{Eqn 5}$$

where:

C_i^L = Total concentration of component *i* in the combined supernatant and entrained solids phases (*M* or Bq/L)

C_i^S = Concentration of component *i* in the entrained solids phase (*M* or Bq/L)

R_F = Ratio of settled solids layer volume to the total feed batch vol%

R_{AS} = 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)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.37	[illegible]
[illegible]	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{3+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{3+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{2-} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{2-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{3-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table F-9 Projected Feed Batch Combined Compositions 0 Percent Settled Solids, Contractor 2 (Tank 241-AP-104)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	C
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba²⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca²⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd²⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe³⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg²⁺		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La³⁺		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni²⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb²⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table F-10 Projected Feed Batch Combined Compositions 2 Percent Settled Solids, Contractor 1 (Tank 241-AP-102)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	C	C	C	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{++}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cs^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{++}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+++}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$CO_3^{=}$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$PO_4^{\equiv}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] [illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 1
[illegible]	[illegible]	[illegible] +[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{3+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^{+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{3+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] [illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] [illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	AP-104 + AP-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
$Al(OH)_4$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{3+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{3+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{2-} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{2-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{3-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

F1.5 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:

$$R_i = \frac{C_i^T}{C_{Na}} \qquad \text{Eqn 6}$$

where:

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

C_{Na} = 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)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
$Al(OH)_4$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{3+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{3+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na (M)	[illegible]	[illegible]	7.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.00	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{2-} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{3-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table F-15 Projected Feed Batch Sodium Ratios 0 Percent Settled Solids, Contractor 2 (Tank 241-AP-104)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	AP-104 +AP-108	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	AP-107	AP-107
Envelope	A	[illegible]	[illegible]	A	A	B	C	C	C	C	C	D
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{3+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{3+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{2+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{2-} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{3-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table F-16 Projected Feed Batch Sodium Ratios 2 Percent Settled Solids, Contractor 1 (Tank 241-AP-102)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible] +AP-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] +AP-[illegible]	[illegible]
Envelope	A	A	A	B	A	B	C	C	C	C	C	B
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Component	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{2+}		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{2-} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{2-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{3-}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

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

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	C
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table F-18 Projected Feed Batch Sodium Ratios 5 Percent Settled Solids, Contractor 1 (Tank 241-AP-102)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
Source Tank	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Envelope	A	A	A	A	A	B	C	C	C	C	C	[illegible]
Volume (L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Component	[illegible]											
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F⁻		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table F-19 Projected Feed Batch Sodium Ratios 5 Percent Settled Solids, Contractor 2 (Tank 241-AP-104)

[illegible]	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	BATCH 7	BATCH 8	BATCH 9	BATCH 10	BATCH 11	BATCH 12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	A	A	A	A	A	B	C	C	C	C	C	C
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OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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F1.6 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:

$$\rho = 1 + 0.2\Big(a[Al]^2 + b[Al] + c[Na]^2 + d[Na] + e[NO_2]^2 + f[NO_3] + g[NO_3]^2 + h[NO_3] + i[OH]^2 + j[OH]\Big) \qquad \text{Eqn 7}$$

(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:

a = -0.0955
b = 0.383
c = -0.0054
d = 0.1096
e = -0.073

f = 0.373
g = 0.00046
h = 0.201
i = 0.0197
j = 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 supernatant 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 supernatants the following is assumed:

- 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, 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., riser) but at different waste depths. If liquids with different densities (and assumably different compositions) are added together in a feed batch, stratified supernatant phases may form unless there is adequate mixing. Potential sources of stratified phases comes from:

- 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 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 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, the following is assumed:

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

The RSDs were calculated with the following equation:

$$RSD_i = \frac{Var\left(\bar{y}_i\right)\cdot l}{\bar{y}_i}\cdot 100\% \qquad \text{Eqn 8}$$

where:

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

$Var(\bar{y}_i)$ = Variance of the mean concentration of component i (M or Bq/L)

l = 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.

Table F-20. Relative Standard Deviations.

Component	Well–Mixed Scenario RSD	Well–Mixed Scenario RRSD	Not–Mixed Scenario RSD	Not–Mixed Scenario RRSD
	from 2AP RSD (%)	ratio RSD (%)	from 5AP RSD (%)	ratio RSD (%)
$Al(OH)_4^-$	5.00	5.49	10.88	13.72
Ba^{+2}	22.93	23.04	43.69	44.48
Ca^{+2}	10.00	10.25	20.00	21.68
Cd^{+2}	6.69	7.08	7.39	11.16
$Cr(OH)_4^-$	3.40	4.09	10.11	13.12
Fe^{+3}	28.20	28.29	21.88	23.42
Hg^{+2}	6.30	6.60	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	
Ni^{+2}	3.00	3.76	8.83	12.16
Pb^{+4}	4.10	4.69	16.24	18.27
U	10.00	10.25	17.50	19.39
CO_3^{-2}	6.86	7.23	22.96	24.43
Cl^-	5.83	6.07	24.18	25.69
F^-	6.10	6.51	15.00	17.17
SO_4^{-2}	7.72	8.05	41.71	42.54
NO_2^-	5.66	6.10	14.99	17.16
NO_3^-	5.49	5.94	10.62	13.52
PO_4^{-3}	7.02	7.35	24.23	25.69
OH^-	2.00	3.03	2.50	8.73
TOC	3.65	4.47	10.04	13.06
^{90}Sr	8.10	8.41	13.44	15.83
^{99}Tc	8.60	8.89	12.39	14.86
^{137}Cs	5.10	5.58	9.86	12.78
TRU				
^{237}Np	17.90	18.04	20.00	21.68
^{238}Pu	10.00	10.25	20.00	21.68
^{239}Pu	10.00	10.25	12.23	14.81
^{240}Pu	10.00	10.25	20.00	21.68
^{241}Pu	10.00	10.25	20.00	21.68
^{241}Am	19.39	19.52	44.10	44.89

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 those 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 supernatant 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:

$$RRSD_i^x = \left[\left(\frac{RSD_i^x}{100} \right)^2 + \left(\frac{RSD_{Na}^x}{100} \right)^2 \right]^{1/2} \cdot 100\% \qquad \text{Eqn 9}$$

where:

RSD_i^x = Relative standard deviation of the component *i* concentration for the *x* scenario.

$RRSD_i^x$ = 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 (σ_i) were calculated for each set of batch, contractor, mixing scenario (well-mixed or not-mixed), and volume of settled solids.

$$\sigma_i = R_i \cdot \frac{RRSD_i^x}{100} \qquad \text{Eqn 10}$$

where:

R_i = 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:

$$\sigma_{Na} = C_{Na} \cdot \frac{RSD_{Na}^{x}}{100} \qquad \text{Eqn 11}$$

where:

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

C_{Na} = Concentration of sodium (*M*)

RSD_{Na}^{x} = 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:

$$\sigma_{t} = C_{t} \cdot \frac{RSD_{t}^{x}}{100} \qquad \text{Eqn 12}$$

where:

C_t = Concentration of transuranic radionuclide *t* (Bq/L)

RSD_t^x = Relative standard deviation of the transuranic radionuclide *t* for the x scenario (percent)

σ_{Na} = 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 (σ_{TRU}) is calculated with the following equation:

$$\sigma_{TRU} = R_{TRU} \cdot \left[\frac{\sum \left(\sigma_t^2\right)}{\left(C_{TRU}\right)^2} + \left(\frac{RSD_{Na}^{x}}{100} \right)^2 \right]^{\frac{1}{2}} \qquad \text{Eqn 13}$$

where:

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

σ_t = Standard deviation in the sampling and analysis for the transuranic radionuclide *t*

C_{TRU} = Total concentration of the transuranic radionuclides (Bq/L).

The calculated standard deviations can be found in Tables F-7AF through F-7BC in Section 5.0 for the zero, two, and five percent settled solids cases.

F2.3 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 criteria. 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 normally distributed around the mean.

The sodium concentration is evaluated against both upper and lower limits and the two-sided 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.

$$S_i = \frac{(t_\alpha + t_\beta)^2 \cdot \sigma_i^2}{(R_i - E_i)^2} + 0.5 \cdot (t_\alpha)^2 \qquad \text{Eqn 14}$$

where:

S_i = Sampling number for component *i*

t_α = t critical value for the Type I (α) error

t_β = t critical value for the Type II (β) error

E_i = 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 feed envelope limit and is determined by the following equation:

$$SR_i = \frac{|E_i - R_i|}{\sigma_i} \qquad \text{Eqn 15}$$

where:

SR_i = Stat ratio for component *i*.

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

Tables F-?AP through F-?BC 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 tanks (V_S) and the confidence interval used (CI). The ratio and sigma values for sodium are in moles per liter and those for the transuranics (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 F-? through F-? 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.

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

Scenario	Well-Mixed		Not-Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	3	3	5	5
6	3	3	9	9
7	19	19	89	89
8	19	19	89	89
9	3	3	10	10
10 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	4	3	15	4
Sub-Total [c]	74	70	291	266
Total [c]	144		557	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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.

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

Scenario	Well-Mixed		Not-Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	3	3	5	5
6	Failed	Failed	Failed	Failed
7	20	20	95	95
8	20	20	95	95
9	3	3	10	10
10 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	Failed	3	Failed	4
Sub-Total [c]	75	72	285	272
Total [c]	147		557	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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.

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

Scenario	Well-Mixed		Not-Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	3	3	5	5
6	Failed	Failed	Failed	Failed
7	21	21	102	102
8	21	21	102	102
9	3	3	10	10
10 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	Failed	3	Failed	4
Sub-Total[c]	77	74	299	286
Total[c]	151		585	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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

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

Scenario	Well-Mixed		Not-Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	3	3	5	5
6	Failed	Failed	Failed	Failed
7	22	22	110	110
8	22	22	110	110
9	3	3	9	9
10 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	Failed	3	Failed	4
Sub-Total [c]	79	76	314	301
Total [c]	155		615	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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.

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

Scenario	Well–Mixed		Not–Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	3	3	5	5
6	Failed	Failed	Failed	Failed
7	24	24	118	118
8	24	24	118	118
9	3	3	9	9
10 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	Failed	3	Failed	4
Sub–Total [c]	83	80	330	317
Total [c]	163		647	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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.

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

Scenario	Well-Mixed		Not-Mixed	
Contractor	1	2	1	2
Batch	Samples		Samples	
1 [a]	3	3	7	7
2 [a]	8	5	47	34
3 [a]	3	3	7	7
4 [a]	3	3	4	4
5 [a]	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 [a]	3	3	4	4
11 [a]	3	3	5	4
12 [b]	Failed	3	Failed	4
Sub-Total [c]	88	85	350	337
Total [c]	173		687	

[a] No solids data available for these batches.

[b] No solids data available for Cntr 2's Batch 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.

F3.0 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/sludges 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.

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

Percent Settled Solids	Total Samples	Batches Exceeding Feed Envelope Criteria	
		Contractor 1	Contractor 2
Well Mixed 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 Mixed 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

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 increased 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

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

Envelope C TRU Limit Bq/Mol Na	Number of Samples Required for All Phase I Feed Batches											
	Well Mixed Scenario						No Mixed Scenario					
	0%	1%	2%	3%	4%	5%	0%	1%	2%	3%	4%	5%
3,000,000	144	147	151	155	163	173	557	557	585	615	647	687
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	363	371
3,300,000	100	99	99	99	103	103	321	301	305	307	311	319
3,400,000	96	95	95	95	95	95	305	281	277	276	279	283
3,500,000	92	91	91	91	91	91				271	267	263
3,600,000	88	87	87	87	87							
3,700,000	86											
3,800,000	84											

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

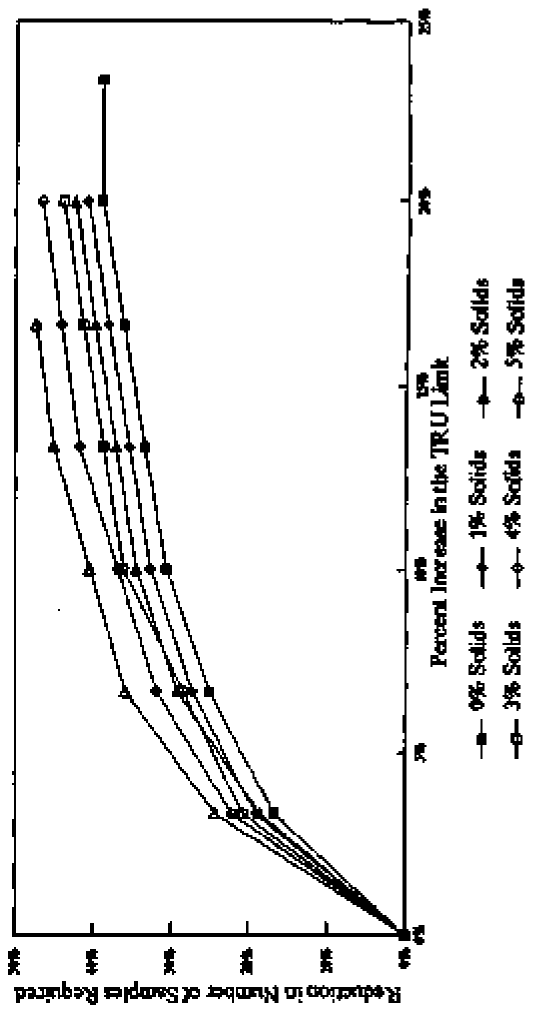
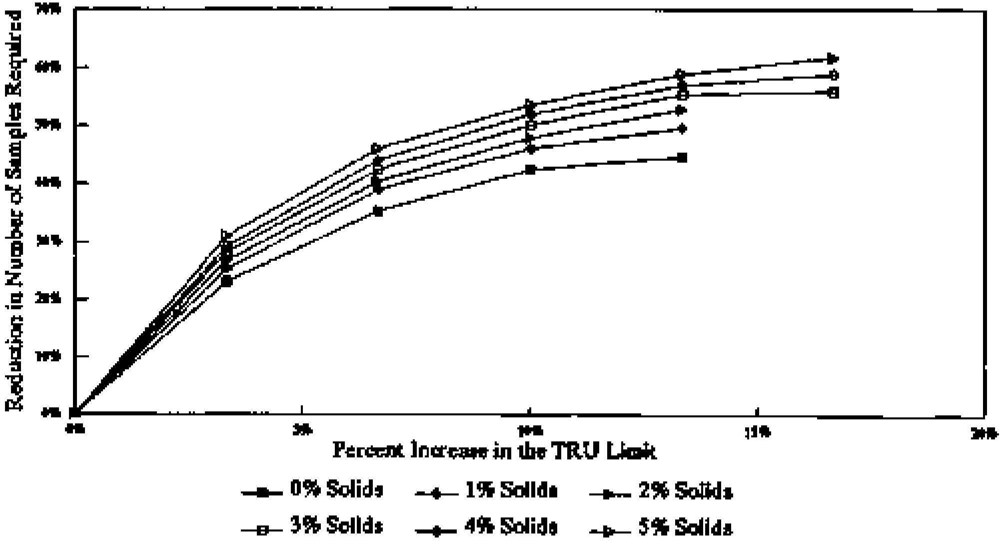


Figure F-30. Sampling Number Reduction versus Transuranic Limit Increase: Not-Mixed Scenario.



F4.0 SAMPLE AND ANALYSIS REQUIREMENTS AND COSTS

F4.1 ANALYTICAL REQUIREMENTS

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

F4.2 SAMPLE SIZE REQUIREMENTS

Table F-31 also lists the volume of sample required for analysis. When received, the bulk samples are tested 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 liquid 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 solids measurement.

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 fee assessed for extrusion of the sample from the core sampler (Rice 1996).

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

Method	Procedure	[illegible]	[illegible]	[illegible]	Blank	Cal. & STD	[illegible]	Analyte/ Property	Expected Range		Units
Bulk Sample											
Bulk Density	TBD						20	Density			
Solids Settling Rate	TBD						[illegible]				
Volume Percent Settled Solids	TBD						[illegible]	% Solids			
Liquid Fraction											
Density							5	Density	1.22	1.38	g/mL
ICP	LA-505-151 LA-505-161	a	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	Al Ba Ca Cd Cr Fe K La Na Ni Pb	4.40E-03 4.72E+00 	1.91E+00 1.08E-04 [illegible] [illegible] [illegible] 1.47E-03 7.25E-01 [illegible] 1.11E+01 [illegible] 1.11E-03	M M M M M M M M M M M
IC	LA-533-105	w	[illegible]	[illegible]	[illegible] PB	[illegible] AB	[illegible]	F Cl NO₂ NO₃ PO₄ SO₄	[illegible] [illegible] 7.7[illegible]E-01 1.[illegible]E+00 4.3[illegible]E-03 7.[illegible]E-03	3.53E-01 2.07E-01 1.73E+00 3.17E+00 5.24E-03 2.33E-01	M M M M M M
CVAA	LA-325-104 LA-325-105	d	[illegible]	[illegible]	[illegible] AB	[illegible] AB		Hg		3.72E-05	M
α counting	LA-508-101	a	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	Total Alpha	7.72E-07	4.30E-04	Bq/L
Sep. & α counting	LA-503-128	a	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	[illegible]Pu [illegible]Pu			Bq/L Bq/L
Sep. & α counting	LA-933-141	a	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	²³⁷Np			Bq/L
GEA	LA-548-121	a	[illegible]	N/A	[illegible] PB	[illegible] AB	[illegible]	¹³⁷Cs ²⁴¹Am		1.32E+00	Bq/L Bq/L
Sep. & β counting	LA-220-101	a	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	⁹⁰Sr		[illegible]	Bq/L
Sep. & [illegible]	LA-[illegible]-101	a or d	[illegible]	See	[illegible] PB	[illegible] AB	[illegible]	⁹⁹Tc		[illegible]	Bq/L
Phosphorescence	LA-925-009	a	[illegible]	[illegible]	[illegible] PB	[illegible] AB	[illegible]	U		3.77E-03	M
Titration	LA-211-1[illegible]	d	[illegible]	N/A	[illegible] AB	[illegible] AB	[illegible]	OH	[illegible]E-01	3.51E+00	M
Persulfate/ coulometry	LA-342-100	w or d	[illegible]	[illegible]	[illegible] PB	[illegible] AB	1	TOC	1.40E-01	[illegible]E+00	M

Table F-31. Intermediate Waste Feed Staging System Feed Batch Sample Analysis Requirements. (Sheet 2 of 3)

Method	Procedure	Prep	Container	Preservative	Blank	Cntrl STD	Volume	Analyte/ Property	Expected Range		Units
Solids Fraction											
ICP	LA-505-151 LA-505-161	a	as reqd	See^f	as PB	as AB	[illegible]	Al Ba Ca Cd Cr Fe K La Na Ni Pb			M M M M M M M M M M M
IC	[illegible]	w	as reqd	None	as PB	as AB		F^- Cl^- NO_2^- NO_3^- PO_4^{3-} SO_4^{2-}			M M M M M M
CVAA^d	LA-325-104 LA-325-106	d	as reqd	None	as AB	as AB	-	Hg			M
α counting	LA-508-101	a	as reqd	See^f	as PB	as AB	[illegible]	Total Alpha			Bq/L
Sep. & α counting^i	LA-943-128	a	as reqd	See^f	as PB	as AB	[illegible]	^{238}Pu $^{239/240}$Pu			Bq/L Bq/L
Sep. & α counting^k	LA-933-141	a	as reqd	See^f	as PB	as AB	[illegible]	^{237}Np			Bq/L
GEA	LA-548-121	a	as reqd	NA	as PB	as AB	[illegible]	^{137}Cs ^{241}Am			Bq/L Bq/L
Sep. & β counting	LA-220-101	a	as reqd	See^f	as PB	as AB	[illegible]	^{90}Sr			Bq/L
Sep. & β/LSC	LA-438-101	a or d	as reqd	See^f	as PB	as AB	[illegible]	^{99}Tc			Bq/L
Phosphorescence^l	LA-925-009	a	as reqd	None	as PB	as AB	[illegible]	U			M
Titration^m	LA-211-102	d	as reqd	NA	as AB	as AB	[illegible]	OH			M
Persulfate/ coulometry	LA-342-100	w or d	as reqd	None	as PB	as AB	1	TOC			M

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

[A] d-direct, f-fusion dissolution, a-acid dissolution, w-water dissolution

[B] ea-each, smpl-sample, DUP-duplicate, SPK/MSD-spike and matrix spike duplicate, AB-analytical batch, PB-preparation blank, N/A-not applicable, mtrx-matrix.

[C] Duplicate refers to a duplicate aliquot taken from the bulk sample

[D] Estimated concentrations from

[E] Use/reuse bulk sample

[F] From bulk sample liquid fraction

[G] From liquid-fraction density

[H] From ICP or IC fusion, water, or acid digestions

[I] Either serial dilutions or matrix spikes will be performed (when applicable)

[J] Tracer or carrier may be used in place of a spike and results corrected for recovery

[K] Cold Vapor Atomic Absorption

[L] May not need to be performed depending on the definition of transuranic waste

[M] Fluorimetry

[N] Acid-Base Titrimetry

F5.0 TABLES

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

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

BATCH 1 Well-Mixed V_s=0% V_t=[illegible] CI=[illegible]	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3				BATCH 4 Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required: 3			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

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

[illegible]	BATCH [illegible] Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3				BATCH [illegible] Envelope B Solids Data Used Source Tank: [illegible] No. of Samples Required: 3				BATCH [illegible] Envelope C Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH [illegible] Envelope D Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
AlOH$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na$^+$ (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO$_3^{-2}$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO$_4^{-2}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_3^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_2^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO$_4^{-3}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
CrOH$_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F$^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO$_4^{-3}$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO$_4^{-2}$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

CASE 1 Well-Mixed [illegible]	BATCH 9 Envelope C Solids Data Used Source Tank: AN-102 No. of Samples Required: 3				BATCH 10 Envelope C Solids Data Not Available for this Tank. Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 12 Envelope B Solids Data Used Source Tank: AY-[illegible] No. of Samples Required: 4			
Component	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Minimum Criteria	# of Samples	RATIO to lim	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

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

CNTR 1 Not Mixed V_s = 0% V_s = [illegible] [illegible]	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: AN-105 No. of Samples Required: 7				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: AP-104 No. of Samples Required: 47				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: AN-104 No. of Samples Required: 7				BATCH 4 Envelope A Solids Data Used Source Tank: AW-101 No. of Samples Required: 4			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ - M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-33 Sample Number Calculations for Contractor 1, Not-Mixed, 0 Percent Settled Solids (Sheet 2 of 3)

[illegible] Not Mixed V_s vol% V_s [illegible] [illegible]	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: AW-[illegible] No. of Samples Required: [illegible]				BATCH 6 Envelope B Solids Data Used Source Tank: AY-101 No. of Samples Required: [illegible]				BATCH 7 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]				BATCH 8 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

[illegible]	BATCH 9 Envelope [illegible] Solids Data Used Source Tank: AN-[illegible] No. of Samples Required [illegible]				BATCH 10 Envelope C Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required [illegible]				BATCH 11 Envelope [illegible] Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required [illegible]				BATCH 12 Envelope [illegible] Solids Data Used Source Tank: AY-101 No. of Samples Required [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO3 (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
F-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

Table F-34 Sample Number Calculations for Contractor 2, Well-Mixed, 0 Percent Settled Solids (Sheet 1 of 3)

[illegible]	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: AW-[illegible] No. of Samples Required 3				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: AP-[illegible] No. of Samples Required 4				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: AW-[illegible] No. of Samples Required 3				BATCH 4 Envelope A Solids Data Used Source Tank: AW-[illegible] No. of Samples Required 3			
Component	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples
Al(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO$_3^{-2}$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_3^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_2^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO$_4^{-3}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples
Na$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Cr(OH)$_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F$^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO$_4^{-3}$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-34 Sample Number Calculations for Contractor 2, Well-Mixed, 0 Percent Settled Solids (Sheet 2 of 3)

CHART 2 Well Mixed	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required 3				BATCH 6 Envelope B Solids Data Used Source Tank: AY-101 No. of Samples Required 3				BATCH 7 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required 10				BATCH 8 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required 10			
V_s=0% V_l=100% D=[illegible]																
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-34 Sample Number Calculations for Contractor 2, Well-Mixed, 0 Percent Settled Solids (Sheet 3 of 3)

Batch # Well Mixed Vs = 0% [illegible] [illegible]	Batch 9 Envelope D Solids Data Used Source Tank: AN-102 No. of Samples Required: 3				Batch 10 Envelope C Solids Data Not Available for this Tank Source Tank: AN-107 No. of Samples Required: 3				Batch 11 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3				Batch 12 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3			
Component	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples
Al(OH)₄⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi⁺³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)₄⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe⁺³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La⁺³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na⁺ mol	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO₄⁻²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO₃⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO₂⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO₄⁻³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples	RAND in Na	Sigma	Maximum Criteria	# of Samples
Na⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl⁻	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Cr(OH)₄⁻	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F⁻	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO₄⁻³	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO₄⁻²	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-35 Sample Number Calculations for Contractor 2, Not-Mixed, 0 Percent Settled Solids (Sheet 1 of 3)

Contr 2 Not Mixed	BATCH 1				BATCH 2				BATCH 3				BATCH 4			
[illegible]	Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required 7				Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required [illegible]				Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required 7				Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required 4			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-35 Sample Number Calculations for Contractor 2, Not-Mixed, 0 Percent Settled Solids (Sheet 2 of 3)

[illegible] 2 Not Mixed Y_s = [illegible]% Y_l = [illegible]% Criteria	BATCH [illegible] Envelope A Solids Data Not Applicable for this Tank Source Tank: AN-[illegible] No. of Samples Required: [illegible]				BATCH [illegible] Envelope B Solids Data Used Source Tank: AZ-101 No. of Samples Required: [illegible]				BATCH F Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]				BATCH [illegible] Envelope D Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
^{239}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{240}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Am	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-35 Sample Number Calculations for Contractor 2, Not-Mixed, 0 Percent Settled Solids (Sheet 3 of 3)

BATCH Not Mixed V_s=0% [illegible]	BATCH 9 Envelope C Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 10 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4				BATCH 12 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$CO_3^=$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4 [illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-36 Sample Number Calculations for Contractor 1, Well-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

BATCH 1 Well-Mixed Y1=[illegible] Y2=[illegible] Criteria	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: AW-[illegible] No. of Samples Required: 3				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: AP-[illegible] No. of Samples Required: [illegible]				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: AW-[illegible] No. of Samples Required: 3				BATCH 4 Envelope A Solids Data Used Source Tank: AW-[illegible] No. of Samples Required: 3			
Component	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	7			0	0			0	0		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples	RATIO in Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-36. Sample Number Calculations for. Contractor 1, Well-Mixed, 2 Percent Settled Solids (Sheet 2 of 3)

CONTR 1 Well-Mixed [illegible] [illegible] CI=95%	BATCH [illegible] Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 2				BATCH [illegible] Envelope B Solids Data Used Source Tank: [illegible] DOE LIMIT MET ENVELOPE CRITERIA				BATCH [illegible] Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: 21				BATCH [illegible] Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: 21			
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
AlO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-36 Sample Number Calculations for Contractor I, Well-Mixed, 2 Percent Settled Solids (Sheet 3 of 3)

[illegible]	BATCH 9 Envelope D Solids Data Used Source Tank AN-102 No. of Samples Required: 3				BATCH 10 Envelope D Solids Data Not Available for this Tank Source Tank [illegible] No. of Samples Required: 3				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank [illegible] No. of Samples Required: 3				BATCH 12 Envelope D Solids Data Used Source Tank AY-101 [illegible]			
Component	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples	[illegible]	Sigma	Maximum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

Table F-37 Sample Number Calculations for Contractor 1, Not-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

CNTR 1 Not Mixed [illegible]	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required [illegible]				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required [illegible]				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required [illegible]				BATCH 4 Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required [illegible]			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-37 Sample Number Calculations for Contractor 1, Not-Mixed, 2 Percent Settled Solids (Sheet 2 of 3)

[illegible] Not Mixed	BATCH [illegible] Envelope A Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: [illegible]				BATCH [illegible] Envelope B Solids Data Used Source Tank: AY-[illegible] DOES NOT MEET ENVELOPE CRITERIA				BATCH 7 Envelope C Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: [illegible]				BATCH [illegible] Envelope D Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-37 Sample Number Calculations for. Contractor 1, Not-Mixed, 2 Percent Settled Solids (Sheet 3 of 3)

Contr. 1 Not Mixed V_s=2% V_x=30% C=[illegible]	BATCH 9 Envelope C Solids Data Used Source Tank: AW-102 No. of Samples Required 10				BATCH 10 Envelope C Solids Data Not Available for this Tank Source Tank AW-10[illegible] No. of Samples Required 4				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank AW-10[illegible] No. of Samples Required 6				BATCH 12 Envelope B Solids Data Used Source Tank AY-101 DOES NOT MEET ENVELOPE CRITERIA			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$AlOH_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]													[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

Table F-38 Sample Number Calculations for Contractor 2, Well-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

[illegible]

Table F-38 Sample Number Calculations for Contractor 2, Well-Mixed, 2 Percent Settled Solids (Sheet 2 of 3)

[illegible]	BATCH 5				BATCH 6				BATCH 7				BATCH 8			
Well Mixed	Envelope A				Envelope B				Envelope C				Envelope C			
[illegible]	Solids Data Not Available for this Tank				Solids Data Used				Solids Data Used				Solids Data Used			
[illegible]	Source Tank: [illegible]				Source Tank: AY-101				Source Tank: AN-107				Source Tank: [illegible]			
[illegible]	No. of Samples Required: 3				DOES NOT MEET ENVELOPE CRITERIA				No. of Samples Required: 21				No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (M)	[illegible]	[illegible]	14.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.81	[illegible]	14.00	[illegible]	7.81	[illegible]	14.00	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$CO_3^=$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$SO_4^=$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21	[illegible]	[illegible]	[illegible]	21
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.81	[illegible]	[illegible]	[illegible]	7.81	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$SO_4^=$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-38 Sample Number Calculations for Contractor 2, Well-Mixed, 2 Percent Settled Solids (Sheet 3 of 3)

[illegible] (Well Mixed) V$_S$=2% V$_L$=[illegible] C=[illegible]	BATCH 9 Envelope C Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 10 Envelope C Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 12 Envelope C Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Al(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na$^+$, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO$_3^{-2}$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_2$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_3^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO$_4^{-3}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Cr(OH)$_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F$^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO$_4$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-39 Sample Number Calculations for Contractor 2, Not-Mixed, 2 Percent Settled Solids (Sheet 1 of 3)

[illegible] Not Mixed V_s=2% V_s=50% CI=95%	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank, AW-[illegible] No. of Samples Required 7				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank, AP-[illegible] No. of Samples Required [illegible]				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank, AW-[illegible] No. of Samples Required 7				BATCH 4 Envelope A Solids Data Used Source Tank, AW-[illegible] No. of Samples Required 4			
Component	Ratio to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{238}Pu																
^{239}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{240}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Am	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	3.00	[illegible]	[illegible]	[illegible]	3.00	[illegible]	[illegible]	[illegible]	3.00	[illegible]	[illegible]	[illegible]	3.00	[illegible]
Cl	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-39 Sample Number Calculations for Contractor 2, Not-Mixed, 2 Percent Settled Solids (Sheet 2 of 3)

[illegible]	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 6 Envelope B Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 7 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]				BATCH 8 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
AlOH₄⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)₄⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe⁺³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La⁺³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na⁺, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb⁺²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO₃⁻² (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO₄⁻²	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO₃⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO₂⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO₄⁻³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH⁻	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
Na⁺	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl⁻	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
Cr(OH)₄⁻	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F⁻	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO₄⁻³	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO₄⁻²	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-39 Sample Number Calculations for Contractor 2, Not-Mixed, 2 Percent Settled Solids (Sheet 3 of 3)

[illegible] Not Mixed Y_S = 2% Y_L = 98% Criteria	BATCH 9 Envelope C Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: [illegible]				BATCH 10 Envelope D Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4				BATCH 12 Envelope D Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 4			
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_3$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_3$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_3$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-40 Sample Number Calculations for Contractor 1, Well-Mixed, 5 Percent Settled Solids (Sheet 1 of 3)

[illegible]	BATCH 1 Envelope A Batch Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 2 Envelope A Batch Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 3 Envelope A Batch Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 4 Envelope A Batch Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
Component	RATIO to Max	Sigma	Maximum Criteria	# of Samples	RATIO to Max	Sigma	Maximum Criteria	# of Samples	RATIO to Max	Sigma	Maximum Criteria	# of Samples	RATIO to Max	Sigma	Maximum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Max	Sigma	Minimum Criteria	# of Samples	RATIO to Min	Sigma	Minimum Criteria	# of Samples	RATIO to Min	Sigma	Minimum Criteria	# of Samples	RATIO to Min	Sigma	Minimum Criteria	# of Samples
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-40   Sample Number Calculations for   Contractor 1, Well-Mixed, 5 Percent Settled Solids   (Sheet 2 of 3)

[illegible]	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 6 Envelope B Solids Data Used Source Tank: [illegible] DOES NOT MEET ENVELOPE CRITERIA				BATCH 7 Envelope C Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 8 Envelope D Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{++}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{--} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{--}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{---}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{---}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{--}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-40 Sample Number Calculations for Contractor 1, Well-Mixed, 5 Percent Settled Solids (Sheet 3 of 3)

CRIT#1 Well-Mixed V_s=5% V_s=95% Cl=[illegible]	BATCH 9 Envelope D Solids Data Used Source Tank: AW-102 No. of Samples Required: 4				BATCH 10 Envelope D Solids Data Not Available for this Tank Source Tank: AW-104 No. of Samples Required: 3				BATCH 11 Envelope D Solids Data Not Available for this Tank Source Tank: AW-1[illegible] No. of Samples Required: 3				BATCH 12 Envelope B Solids Data Used Source Tank: AY-101 DOES NOT MEET ENVELOPE CRITERIA			
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
$Al(OH)_4^-$	2.18E-02	2.00E-03	1.00E-01	2	6.94E-02	2.32E-03	1.00E-01	2	7.80E-02	2.00E-03	1.00E-01	2	7.14E-02	1.42E-03	1.00E-01	2
Ba^{+2}	4.07E-06	1.14E-05	1.00E-04	3	2.46E-06	8.47E-06	1.00E-04	2	8.51E-07	1.28E-07	1.00E-04	2	3.00E-04	9.11E-05	1.00E-04	1
Ca^{+2}	1.10E-03	1.18E-04	4.00E-02	2	2.18E-06	2.06E-06	4.00E-02	2	7.21E-05	7.26E-06	4.00E-02	2	2.53E-03	2.00E-04	4.00E-02	2
Cd^{+2}	4.00E-06	3.31E-07	4.00E-03	2	7.31E-06	8.32E-09	4.00E-03	2	4.00E-06	4.00E-06	4.00E-03	2	1.75E-06	1.24E-10	4.00E-03	2
$Cr(OH)_4^-$	6.76E-04	2.20E-05	6.00E-03	2	1.42E-06	5.79E-07	6.00E-03	2	1.80E-06	7.27E-07	6.00E-03	2	6.30E-03	3.45E-04	2.00E-02	2
Fe^{+3}	1.62E-04	4.54E-05	1.00E-02	2	4.17E-06	1.46E-06	1.00E-02	2	3.30E-06	9.34E-07	1.00E-02	2	7.86E-02	7.02E-03	1.00E-02	1
Hg^{+2}	3.37E-10	4.77E-11	1.00E-05	2	1.86E-10	8.41E-12	1.00E-05	2	7.27E-11	2.77E-12	1.00E-05	2	1.30E-12	1.11E-13	1.00E-05	2
K^+	6.46E-03	3.72E-04	1.00E-01	2	2.31E-03	1.06E-04	1.00E-01	2	2.36E-03	1.06E-04	1.00E-01	2	1.41E-02	7.11E-04	1.00E-01	2
La^{+3}	1.76E-06	3.46E-07	8.00E-05	2	1.73E-11	7.77E-12	8.00E-05	2	1.00E-06	1.00E-07	8.00E-05	2	2.82E-03	2.88E-04	8.00E-05	1
Na^+ mole	7.97	1.14	14.00	2	6.10	0.10	14.00	2	11.00	0.29	14.00	2	4.32	0.10	14.00	2
Ni^{+2}	1.07E-04	2.11E-06	3.00E-03	2	1.60E-06	5.29E-07	3.00E-03	2	1.41E-06	5.41E-07	3.00E-03	2	4.35E-04	1.04E-05	3.00E-03	2
Pb^{+2}	4.34E-06	2.22E-07	6.00E-04	2	2.76E-07	9.46E-08	6.00E-04	2	1.34E-07	6.67E-08	6.00E-04	2	1.76E-04	5.26E-06	6.00E-04	2
U	2.54E-06	2.48E-07	1.20E-03	2	1.51E-07	1.55E-08	1.20E-03	2	1.55E-06	1.56E-07	1.20E-03	2	8.36E-04	6.06E-05	1.20E-03	2
CO_3^{-2}(TIC)	1.00E-02	7.22E-03	3.00E-01	2	6.17E-02	4.48E-03	3.00E-01	2	4.23E-02	4.50E-03	3.00E-01	2	1.58E-01	1.06E-02	3.00E-01	2
Cl^-	6.78E-03	3.04E-04	3.70E-02	2	2.06E-03	1.76E-05	3.70E-02	2	3.31E-03	2.10E-05	3.70E-02	2	7.66E-04	4.86E-05	3.70E-02	2
F^-	6.10E-03	5.06E-04	9.10E-02	2	6.63E-03	6.37E-04	9.10E-02	2	7.91E-03	4.81E-04	9.10E-02	2	2.60E-03	1.36E-03	9.10E-01	2
SO_4^{-2}	1.28E-02	1.01E-03	2.00E-02	2	7.10E-03	5.00E-04	2.00E-02	2	7.85E-03	5.39E-04	2.00E-02	2	4.57E-02	3.68E-03	7.00E-02	2
NO_3^-	3.06E-01	1.46E-02	6.00E-01	2	2.46E-01	1.71E-02	6.00E-01	2	2.86E-01	1.75E-02	6.00E-01	2	5.36E-01	1.36E-02	6.00E-01	2
NO_2^-	1.34E-01	9.10E-03	3.80E-01	2	1.55E-01	8.48E-03	3.80E-01	2	1.58E-01	8.80E-03	3.80E-01	2	2.73E-01	1.00E-02	3.80E-01	2
PO_4^{-3}	4.08E-03	3.18E-04	2.00E-02	2	4.50E-03	9.57E-04	2.00E-02	2	6.74E-03	3.45E-04	2.00E-02	2	9.96E-03	4.20E-04	1.30E-01	2
OH^-	5.38E-02	1.06E-03	7.00E-01	2	3.72E-02	1.16E-03	7.00E-01	2	4.62E-02	1.46E-03	7.00E-01	2	1.06E-01	3.40E-03	7.00E-01	2
TOC	2.39E-01	1.63E-02	3.00E-01	2	2.73E-01	1.23E-02	5.00E-01	2	2.76E-01	1.21E-02	5.00E-01	2	1.34E-01	5.00E-03	5.00E-02	1
^{90}Sr	3.18E+06	2.86E+07	[illegible]	2	6.81E+04	5.73E+03	1.00E+05	2	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]	5.70E+07	1
^{99}Tc	1.21E+06	1.07E+06	7.10E+06	2	2.48E+04	7.30E+03	7.10E+06	2	1.40E+06	1.32E+06	7.10E+06	2	6.42E+06	2.53E+06	7.10E+06	1
^{137}Cs	4.16E+06	5.60E+07	4.30E+06	2	2.30E+07	1.20E+06	4.30E+06	2	6.34E+07	4.60E+06	4.30E+06	1	1.41E+06	7.86E+04	[illegible]	3
TRU	8,072,018	843,680	3.00E+06	4	21,070	1,720	3.00E+06	2	36,481	2,882	3.00E+06	1	445,780	67,363	[illegible]	3
[illegible]	3	1			0	0			0	0			2,732	486		
[illegible]																
[illegible]	8,758,878	875,888			34,541	3,454			40,630	4,063			465,761	46,576		
[illegible]	781,316	78,131			8,080	808			52,467	5,246			116,438	11,643		
[illegible]	2,719,429	271,943			34,566	3,456			78,361	7,836			732,477	73,248		
[illegible]	5,496,988	549,699			45,438	4,543			164,449	16,444			765,028	67,503		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na	7.97	0.14	3.00	3	6.10	0.10	3.00	3	11.00	0.25	3.00	3	4.32	0.10	[illegible]	1
Cl^-	6.78E-03	3.04E-04			2.06E-04	1.76E-05			3.31E-03	2.10E-05			7.66E-04	4.86E-05	5.76E-02	1
$Cr(OH)_4^-$	6.76E-04	2.20E-05			1.42E-06	5.79E-07			1.80E-06	7.27E-07			6.30E-03	3.45E-04	6.40E-03	2
F^-	6.10E-03	5.06E-04			6.63E-03	6.37E-04			7.91E-03	4.81E-04			2.60E-03	1.36E-03	9.70E-02	1
PO_4^{-3}	4.08E-03	3.18E-04			4.50E-03	9.57E-04			6.74E-03	3.45E-04			9.96E-03	4.20E-04	3.40E-02	1
SO_4^{-2}	1.28E-02	1.01E-03			7.10E-03	5.00E-04			7.85E-03	5.39E-04			4.57E-02	3.68E-03	6.30E-02	3
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			1.41E+06	7.86E+04	4.30E+06	2
TOC	2.39E-01	1.63E-02	3.00E-02	3	2.73E-01	1.23E-02	4.00E-02	3	2.76E-01	1.21E-02	5.00E-02	3	1.34E-01	5.00E-03		

Table F-41 Sample Number Calculations for Contractor I, Not-Mixed, 5 Percent Settled Solids (Sheet 1 of 3)

BATCH 1 Not Mixed V_s=5% V_L=30% CI=95%	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 7				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 17				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 7				BATCH 4 Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-					[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-41 Sample Number Calculations for Contractor 1, Not-Mixed, 5 Percent Settled Solids (Sheet 2 of 3)

CASE 1 Not Mixed V_s=5% V_L=95% Cr=0%	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: AW-103 No. of Samples Required: [illegible]				BATCH 6 Envelope B Solids Data Used Source Tank: AY-101 DOES NOT MEET ENVELOPE CRITERIA				BATCH 7 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]				BATCH 8 Envelope C Solids Data Used Source Tank: AN-107 No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Al(OH)$_4$	1.40E-01	1.80E-02	1.80E-01	8	6.11E-02	1.11E-02	1.00E-01	9	9.14E-02	1.33E-02	1.40E-01	2	9.14E-02	1.33E-02	1.40E-01	2
Ba^{+2}	2.80E-05	1.50E-10	1.00E-04	2	2.40E-04	1.75E-04	1.00E-04	1	1.91E-05	6.40E-10	1.00E-04	2	1.91E-05	6.40E-10	1.00E-04	2
Ca^{+2}	1.40E-04	2.40E-05	4.00E-02	2	2.38E-03	5.70E-04	4.00E-02	8	1.38E-03	3.07E-04	4.00E-02	2	1.38E-03	3.07E-04	4.00E-02	2
Cd^{+2}	7.40E-05	1.80E-05	4.00E-03	2	7.01E-04	1.20E-07	4.00E-03	8	8.10E-05	3.40E-05	4.00E-03	2	3.10E-05	3.40E-05	4.00E-03	2
Cr(OH)$_4^-$	1.10E-03	1.41E-04	8.30E-03	2	7.60E-03	1.60E-03	2.30E-02	8	4.72E-04	6.20E-05	8.10E-03	2	4.72E-04	6.20E-05	8.10E-03	2
Fe^{+3}	4.41E-03	1.07E-03	1.00E-02	2	2.40E-03	5.60E-03	1.00E-02	1	2.00E-03	5.00E-04	1.00E-02	2	2.00E-03	5.00E-04	1.00E-02	2
Hg^{+2}	8.32E-08	1.12E-07	1.00E-05	3	6.31E-07	1.00E-07	1.00E-05	2	1.79E-08	3.00E-08	1.00E-05	2	1.79E-08	3.00E-08	1.00E-05	2
K$^+$	6.00E-02	3.40E-03	1.80E-01	2	1.11E-03	1.17E-03	1.00E-01	6	6.01E-02	6.00E-04	1.00E-01	2	6.01E-02	6.00E-04	1.00E-01	2
La^{+3}	1.00E-11	3.00E-12	4.00E-05	0	2.40E-05	5.71E-04	4.00E-05	1	2.01E-05	4.00E-06	4.00E-05	2	2.01E-05	4.00E-06	4.00E-05	2
Na$^+$, mg	4.80	0.59	14.00	0	6.97	8.41	14.00	2	7.10	0.60	14.00	2	7.10	0.60	14.00	2
Ni^{+2}	2.73E-05	3.31E-05	3.00E-03	8	1.00E-04	4.40E-04	3.00E-03	2	7.71E-04	8.40E-05	3.00E-03	2	7.71E-04	8.40E-05	3.00E-03	2
Pb^{+2}	8.00E-05	4.00E-05	6.00E-04	2	1.71E-04	3.10E-04	6.00E-04	6	1.02E-04	6.00E-05	6.00E-04	2	1.02E-04	6.00E-05	6.00E-04	2
U	2.52E-05	4.00E-07	1.20E-03	3	7.40E-04	1.47E-04	1.20E-03	4	1.10E-04	2.10E-05	1.20E-03	2	1.10E-04	2.10E-05	1.20E-03	6
CO$_3^{-2}$ (TIC)	1.22E-02	2.37E-03	3.00E-01	2	1.25E-01	3.00E-02	3.00E-01	3	1.26E-01	3.00E-02	3.00E-01	3	1.26E-01	3.00E-02	3.00E-01	3
Cl	1.14E-02	4.72E-03	3.70E-02	4	2.00E-02	7.41E-04	6.90E-02	3	6.70E-03	2.50E-03	3.70E-02	2	6.70E-03	2.50E-03	3.70E-02	2
F	2.00E-02	4.41E-04	9.10E-02	3	1.01E-02	3.11E-03	2.00E-01	2	3.42E-04	5.70E-05	8.10E-02	1	3.42E-04	5.70E-05	8.10E-02	2
SO$_4^{-2}$	1.14E-03	4.00E-04	9.70E-03	2	4.30E-03	1.00E-02	7.00E-02	4	1.51E-02	6.41E-03	2.00E-02	22	1.51E-02	6.41E-03	2.00E-02	22
NO$_2$	1.11E-01	3.11E-02	8.00E-01	2	2.12E-01	3.72E-02	8.00E-01	2	3.00E-01	4.00E-03	8.00E-01	3	3.00E-01	4.00E-03	8.00E-01	3
NO$_3$	2.00E-01	7.00E-02	3.00E-01	3	4.47E-01	3.41E-02	3.00E-01	4	1.10E-01	1.87E-03	3.00E-01	2	1.10E-01	1.87E-03	3.00E-01	2
PO$_4^{-3}$	7.10E-04	1.00E-04	3.10E-02	2	5.22E-03	1.34E-03	1.30E-01	1	6.10E-04	2.00E-04	3.10E-02	2	6.10E-04	2.00E-04	3.10E-02	2
OH$^-$	3.00E-01	6.41E-02	7.00E-01	8	1.41E-01	1.30E-02	7.00E-01	2	1.07E-01	6.31E-03	7.00E-01	2	1.07E-01	6.31E-03	7.00E-01	2
TOC	4.10E-02	6.41E-03	6.00E-02	4	1.10E-01	1.10E-02	6.00E-02	7	2.80E-01	4.70E-02	3.00E-01	4	2.80E-01	4.70E-02	3.00E-01	4
^{90}Sr	3.22E+07	5.10E+06	5.70E+07	3	4.30E+06	8.00E+07	5.70E+07	7	3.81E+06	5.70E+07	8.00E+06	7	3.81E+06	5.70E+07	8.00E+06	1
^{99}Tc	4.34E+05	8.40E+04	7.10E+06	2	2.50E+05	5.00E+05	7.10E+06	2	1.10E+00	1.70E+00	7.10E+00	2	1.10E+00	1.70E+00	7.10E+00	2
^{137}Cs	1.00E+00	2.40E+00	4.30E+00	2	7.30E+10	1.00E+09	9.00E+10	2	1.34E+00	1.71E+00	4.30E+00	2	1.34E+00	1.71E+00	4.30E+00	2
TRU	49,200	3,900	6.00E+04	2	16,005,470	3,461,200	6.00E+04	7	2,895,000	1,095,897	2.00E+04	159	2,895,000	1,095,897	2.00E+04	159
^{237}Np	340	80			2,670	534			100	32			100	32		
^{238}Pu																
^{239}Pu	22,310	4,000			1,596,157	1,029,201			1,054,410	180,177			1,054,410	180,177		
^{240}Pu	6,370	1,670			2,497,214	430,473			357,479	53,400			357,479	53,400		
^{241}Pu	82,700	16,300			2,177,631	405,800			1,294,000	230,827			1,294,000	230,827		
^{241}Am	49,000	17,000			[illegible]	13,650,503			10,351,670	7,329,847			10,351,670	7,329,847		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na$^+$	4.80	0.53	3.00	4	4.87	0.31	3.00	4	7.10	0.80	3.00	4	7.10	0.80	3.00	4
Cl$^-$	1.14E-02	4.72E-03			1.00E-02	7.41E-04	3.70E-02	4	6.70E-03	2.50E-03			6.70E-03	2.50E-03		
Cr(OH)$_4$	1.10E-03	1.41E-04			7.60E-03	1.60E-03	8.30E-03	18	4.72E-04	6.00E-05			4.72E-04	6.00E-05		
F$^-$	2.00E-03	4.41E-04			1.01E-02	3.11E-03	9.10E-03	6	3.42E-04	5.70E-05			3.42E-04	5.70E-05		
PO$_4^{-3}$	7.10E-04	1.00E-04			5.22E-03	1.34E-03	3.00E-02	6	6.10E-04	2.00E-04			6.10E-04	2.00E-04		
SO$_4^{-2}$	1.14E-03	4.00E-04			4.30E-03	1.00E-02	9.70E-03	4	1.51E-02	6.41E-03			1.51E-02	6.41E-03		
^{137}Cs	1.00E+00	2.40E+00			1.30E+10	1.00E+09	4.30E+00	3	1.34E+00	1.71E+00			1.34E+00	1.71E+00		
TOC	4.10E-02	3.41E-03			1.10E-01	1.10E-02			2.80E-01	4.70E-02	6.00E-02	3	2.80E-01	4.70E-02	6.00E-02	3

Table F-41 Sample Number Calculations for Contractor 1, Not-Mixed, 5 Percent Settled Solids (Sheet 3 of 3)

Cont'r 1 Not Mixed Y_s=5% Y_c=95% [illegible]	BATCH 9 Envelope C Solids Data Used Source Tank: AN-1[illegible] No. of Samples Required: [illegible]				BATCH 10 Envelope C Solids Data Not Available for this Tank Source Tank: AN-1[illegible] No. of Samples Required: 4				BATCH 11 Envelope C Solids Data Not Available for this Tank Source Tank: AN-1[illegible] No. of Samples Required: [illegible]				BATCH 12 Envelope B Solids Data Used Source Tank: AZ-1[illegible] DOES NOT MEET ENVELOPE CRITERIA			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

Table F-42 Sample Number Calculations for Contractor 2, Well-Mixed, 5 Percent Settled Solids (Sheet 1 of 3)

CASE 2 Well Mixed [illegible]	BATCH 1 Envelope A Solids Data Not Applicable for this Tank Source Tank: [illegible] No. of Samples Required: 3				BATCH 2 Envelope A Solids Data Not Applicable for this Tank Source Tank: AP-[illegible] No. of Samples Required: 4				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: 3				BATCH 4 Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required: 3			
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-42 Sample Number Calculations for Contractor 2, Well-Mixed, Percent Settled Solids (Sheet 2 of 3)

ENTIRE Well Mixed [illegible]	BATCH 5 Envelope A Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required [illegible]				BATCH 6 Envelope B Solids Data Used Source Tank: AY-101 DOES NOT MEET ENVELOPE CRITERIA				BATCH 7 Envelope C Solids Data Used Source Tank: AN-[illegible] No. of Samples Required [illegible]				BATCH 8 Envelope D Solids Data Used Source Tank: AN-[illegible] No. of Samples Required [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-42. Sample Number Calculations for Contractor 2, Well-Mixed, Percent Settled Solids (Sheet 3 of 3)

[illegible] Well-Mixed V_F=[illegible] V_S=[illegible] C=[illegible]	BATCH 15 Envelope C Batch Data Used Source Tank: AN-[illegible] No. of Samples Required: 4				BATCH 16 Envelope C Batch Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 17 Envelope C Batch Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: 3				BATCH 18 Envelope C Batch Data Not Available for this Tank Source Tank: AY-101 No. of Samples Required: 3			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (mol)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] total	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-43 Sample Number Calculations for Contractor 2, Not-Mixed, 5 Percent Settled Solids (Sheet 1 of 3)

[illegible] (Not Mixed)	BATCH 1 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 2 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 3 Envelope A Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 4 Envelope A Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]			
[illegible]																
Component	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples	Ratio to Na	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bi^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+, molar	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples	RATIO to Na	Sigma	Minimum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		

Table F-43 Sample Number Calculations for Contractor 2, Not-Mixed, 5 Percent Settled Solids (Sheet 2 of 3)

[illegible]	Batch [illegible] Envelope A Solids Data Not Available for this Tank Source Tank: AN-[illegible] No. of Samples Required: [illegible]				Batch [illegible] Envelope B Solids Data Used Source Tank: AY-[illegible] No. of Samples Required: [illegible]				Batch [illegible] Envelope [illegible] Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: [illegible]				Batch [illegible] Envelope [illegible] Solids Data Used Source Tank: AN-[illegible] No. of Samples Required: [illegible]			
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Al(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cr(OH)$_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na$^+$ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO$_3^{-2}$ (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO$_4^{-2}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_3^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO$_2^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO$_4^{-3}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH$^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]																
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples	RATIO to Na	Sigma	Maximum Criteria	# of Samples
Na$^+$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl$^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
Cr(OH)$_4^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
F$^-$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
PO$_4^{-3}$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
SO$_4^{-2}$	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table F-43 Sample Number Calculations for Contractor 2, Not-Mixed, 5 Percent Settled Solids (Sheet 3 of 3)

CASE F Not Mixed V_s = 5% V_s = [illegible] Criteria	BATCH 9 Envelope C Solids Data Used Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 10 Envelope D Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 11 Envelope D Solids Data Not Available for this Tank Source Tank: [illegible] No. of Samples Required: [illegible]				BATCH 12 Envelope C Solids Data Not Available for this Tank Source Tank: AY-101 No. of Samples Required: [illegible]			
Component	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples
$Al(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ba^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cd^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$Cr(OH)_4^-$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hg^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
La^{+3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na^+ (M)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ni^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pb^{+2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CO_3^{-2} (TIC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO_4^{-2}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_3^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO_2^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PO_4^{-3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OH^-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{90}Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{99}Tc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{137}Cs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TRU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
^{237}Np	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{238}Pu																
^{239}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{240}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Pu	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{241}Am	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
Component	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples	Mean to Me	Sigma	Maximum Criteria	# of Samples
Na^+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cl^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
$Cr(OH)_4^-$	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
F^-	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
PO_4^{-3}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
SO_4^{-2}	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
^{137}Cs	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]			[illegible]	[illegible]		
TOC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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F6.0 NOMENCLATURE

C_i^y	Concentration of component *I* in the y phase *M*
C_i^T	Total concentration of component *I* in the combined supernatant and entrained solids phases *M* or Bq/L
C_i^L	Concentration of component *I* in the supernatant phase *M*
C_i^S	Concentration of component *I* in the entrained solids phase *M* or Bq/L
C_r^L	Concentration of radionuclide *r* in the supernatant phase Bq/L
C_{Na}	Concentration of sodium *M*
D	Dilution factor, ratio of staged feed batch volume to retrieved - waste volume.
E_i	Feed envelope concentration of component *I* moles *I*/moles Na
I	Number of sample locations -
M_i	Mass of component *I* in the batch MT
M_r	Mass of radionuclide *r* in the batch Bq
MW_i	Molecular weight of component *I* g/mole
$R_{A/C}$	Ratio of the actual solids volume to the total volume in the percent (L actual solids/compacted sludge layer in the source tank L sludge layer)
$R_{A/S}$ or V_S	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_i	Ratio of the component *I* concentration to the sodium moles *I*/moles Na or concentration. Bq *r*/moles Na
R_F^{max}	Maximum permissible ratio of the settled solids layer volume percent (L settled solids/to the feed batch volume L Feed)
R_F or V_F	Ratio of the settled solids layer volume to the feed batch percent (L settled solids/volume L Feed)
R_E^{max}	Maximum permissible volume of compacted sludge layer percent (L sludge layer/entrained in the retrieved waste L retrieved waste)
$RRSD_i^x$	Ratio of RSD_i to RSD_{Na} percent
RSD_i^x	Relative Standard Deviation of the *I* concentration for the x scenario percent
S_i	Sample Number samples
SR_i	Stat Ratio for component *I* -
V_B	Volume of the Batch L Feed
V_{ESL}^{max}	Maximum volume of sludge layer that can be entrained ML
V_R	Volume of waste retrieved from the source tank ML
$Var(\bar{y}_i)$	Variance of the mean concentration of component *I*
$\bar{y}_i$	Mean concentration of component *I* *M* or Bq/L

Greek Letters

α	Type 1 error, single-sided test
α'	Type 1 error, double-sided test used for sodium
β	Type 2 error, single-sided test
σ_i	Standard deviation in the sampling and analysis for component i.

Subscripts

i	Component i (analyte, radionuclide, or transuranic radionuclide)
r	Radionuclide r
Na	Sodium
t	Transuranic radionuclide t
TRU	Transuranics

Superscripts

C	Combined supernatant and entrained solids phases.
L	Supernatant (liquid) phase.
max	Maximum
nm	Not-Mixed Scenario
S	Entrained solids phase.
wm	Well-Mixed Scenario.
x	Either the "Not-Mixed" (nm) or "Well-Mixed" (wm) scenario.

F7.0 REFERENCES

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernatants*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico

Certa, P. J., W. H. Grams, C. M. McConville, L. W. Shelton, and E. J. Slaathaug, 1996, *Low-Level Waste Feed Staging Plan*, WHC-SD-WM-RPT-224, Rev. 0, Westinghouse Hanford Company, Richland, Washington

Rice, A. D., 1996, CCMail to M. D. Britton, *Re: Cost Estimates for IWFST Sample Analysis*, August 8, 1996, Westinghouse Hanford Company, Richland Washington

Shelton, L. W., Jr., 1996, *Projected Double-Shell Tank Supernatant Compositions for Phase I Privatization*, WHC-SD-WM-TI-751, Rev. 0, Westinghouse Hanford Company, Richland Washington

Simpson, B. C., 1994a, *Tank Characterization Report for Double Shell Tank 241-AP-105*, WHC-SD-WM-ER-358, Rev 0, Westinghouse Hanford Company, Richland Washington

Simpson, B. C., 1994b, *Tank Characterization Report for Double Shell Tank 241-AP-102*, WHC-SD-WM-ER-360, Rev 0, Westinghouse Hanford Company, Richland Washington

Welsh, T. L., 1994a, *Tank 241-AP-102 Characterization and Grout Product Test Results*, WHC-SD-WM-TRP-168, Rev. 1, Westinghouse Hanford Company, Richland, Washington

Welsh, T. L., 1994a, *Tank 241-AP-105 Characterization and Grout Product Test Results*, WHC-SD-WM-TRP-169, Rev. 0, Westinghouse Hanford Company, Richland, Washington

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