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ENGINEERING DATA TRANSMITTAL

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Page 1 of 1

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E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

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		Design Authority			
		Design Agent			
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Application of "Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X" to Specific Feed Batches

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U.S. Department of Energy Contract DE-AC06-96RL13200

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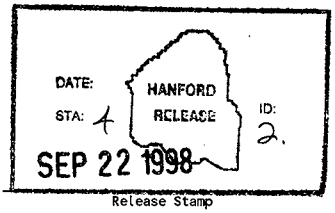
Abstract: This document addresses the characterization needs of tanks as set forth in the *Data Quality Objectives for TWRS Privatization Phase I: Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X* (Crawford et al. 1998).



9/22/98
Release Approval Date

Release Stamp

Approved for Public Release

HNF-3427
Revision 0

APPLICATION OF "CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X" TO SPECIFIC FEED BATCHES

September 1998

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Richland, Washington

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CONTENTS

LIST OF FIGURES

LIST OF TERMS

DQO	Data Quality Objective
ESP[1]	Environmental Simulation Program
HLW	High-level waste
PSDQO	Problem-Specific Data Quality Objectives
TSAP	Tank Sampling and Analysis Plan
TWRS	Tank Waste Remediation System

[1]ESP is a trademark of OLI Systems, Inc.

APPLICATION OF "CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X" TO SPECIFIC FEED BATCHES

1.0 INTRODUCTION

This document addresses the characterization needs of tanks as set forth in the *Data Quality Objectives for TWRS Privatization Phase I: Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X* (Crawford et al. 1998).

The primary purpose of this document is to collect existing data and identify the data needed to determine whether or not the feed source(s) are appropriate for a specific batch. To answer these questions, the existing tank data must be collected and a detailed review performed.

If the existing data are insufficient to complete a full comparison, additional data must be obtained from the feed source(s). Additional information requirements need to be identified and formally documented, then the source tank waste must be sampled or resampled and analyzed. Once the additional data are obtained, the data shall be incorporated into the existing database for the source tank and a reevaluation of the data against the Data Quality Objective (DQO) must be made.

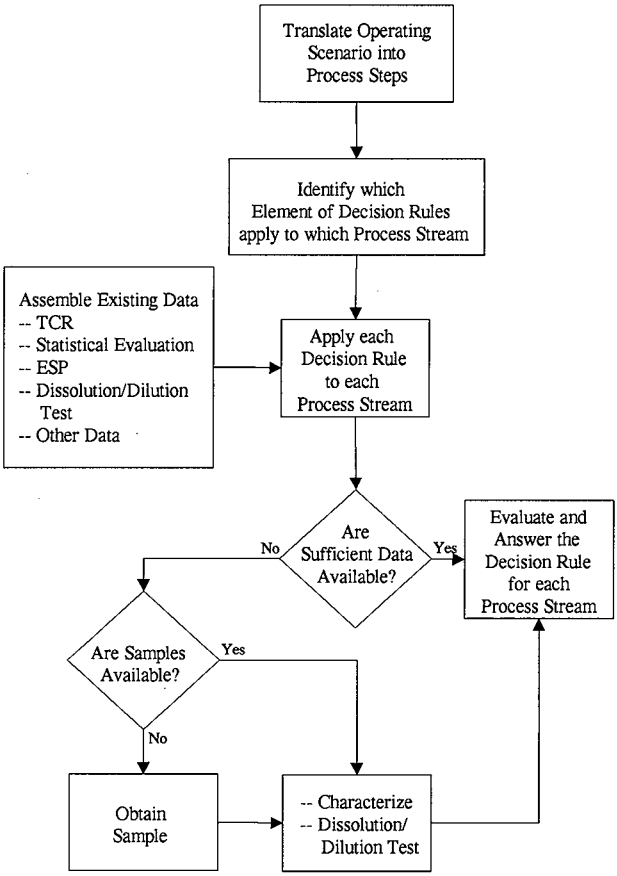
2.0 APPROACH

The Tank Waste Retrieval Division has determined that a strategic and cost-effective way to identify the data needed for high-level waste (HLW) feed delivery is to define those data needs on a batch-by-batch basis using the DQO process. The overall decision logic is shown schematically in Figure 2-1.

The first step in identifying the data need is for the Tank Waste Retrieval Division to translate its operating scenario into a series of process steps (essentially a process flowsheet) that clearly defines the waste to which each element of the decision rule applies. Alternatives to the baseline operating scenario may also be addressed.

The second step is to apply the decision rule to each group of operating scenario activities that constitute a source of waste feed going to the waste feed staging tanks.

Figure 2-1. Overall Decision Logic.



ESP[1] = Environmental Simulation Program
TCR = Tank Characterization Report

[1]ESP is a trademark of OLI Systems, Inc.

The third step is to determine if the data needed to address each element can be supplied by or approximated with existing (Best-Basis Inventory) or new characterization data on the waste, statistical evaluations, mathematical or process models such as Environmental Simulation Program (ESP[1]), or by process testing on existing or new samples including dissolution/dilution testing.

If the existing data are insufficient to complete a full evaluation, additional data must be obtained from Tank T. The missing information needs to be identified and formally documented in this document. Unless sufficient archived samples can be found, Tank T waste must be sampled and analyzed. Once these data are obtained, they shall be compiled into the existing database for Tank T and a reevaluation of the data must be made.

3.0 REFERENCES

Crawford, T. W., R. D. Schreiber, and J. Jo, 1998, *Data Quality Objectives for TWRS Privatization Phase I: Confirm Tank T is an Appropriate Feed source for High-Level Waste Feed Batch X,* HNF-1558 Rev. 0 (Draft), Numatec Hanford Corporation, Richland, Washington.

[1]ESP is a trademark of OLI Systems, Inc.

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ADDENDUM 1

APPLICATION OF

"CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X"

TO

241-AZ-101 / BATCHES 1 AND 2

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CONTENTS

LIST OF TABLES

LIST OF TERMS

AGA	Alternatives generation and analysis
BBI	Best-Basis Inventory
DOE	U.S. Department of Energy
DST	Double-shell tank
ESP	Environmental Simulation Program
HLW	High-Level Waste
IC	Ion chromatography
ICD	Interface Control Document
ICP	Inductively coupled plasma
LAW	Low-Activity Waste
M	Molar (gmoles/liter)
M&I	Management and Integration
NVO	Non-volatile oxides
PHMC	Project Hanford Management Contract(or)
PMBS	Project Master Baseline Schedule
PSDQO	Problem-Specific Data Quality Objectives
RL	U.S. Department of Energy-Richland Operations Office
TANK T	Refers to the contents from one tank, multiple tanks, or portions of one or more tanks that will be used to prepare a feed batch
TOC	Total Organic Carbon
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
URSILLA	Ultrasonic interface level analyzers
USQ	Unreviewed Safety Question
WIT	Waste Disposal Integration Team

APPLICATION OF "CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X" TO 241-AZ-101 / BATCHES 1 AND 2

1.0 INTRODUCTION

This addendum applies Revision 0 of "Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X" problem-specific data quality objectives (PSDQO) to tank 241-AZ-101 / Batches 1 and 2.

This application of PSDQO-02 (Crawford et al. 1998) describes the Base Case Operating Scenario, which pretreats the waste in tank 241-AZ-101 prior to transfer to the Privatization Contractor.

There is one base case operating scenario for 241-AZ-101 whose elements are described. Table 1 in Section 2.0 contains specific information specific to 241-AZ-101 addressing all elements in Section 6 of the PSDQO on Confirm Tank T for HLW. Table 2 in Section 2.0 covers the specific new data required by the waste feed delivery program to confirm that 241-AZ-101 is an appropriate feed source.

2.0 EVALUATION

2.1 BASE CASE OPERATING SCENARIO

Translate the operating scenario into a series of process steps.

The base case operating scenario from the *Waste Feed Delivery Technical Basis, Volume II, Waste Feed Delivery Flowsheet* (Papp 1998) includes the following steps to make up Batches 1 and 2:

Step Description

(1) **Decant Initial Supernate.** Decant the supernate to the appropriate DST. The supernate from 241-AZ-101 will be transferred to 241-AY-101. The solids content will be monitored using a turbidity meter or other in-line instrument. Stop the decant when the solids content reaches a predefined limit, indicating that the supernate/settled solids interface has been reached.

The decant transfer pump will be capable of decanting liquid with a variable depth inlet that is adjustable from the tank's maximum operating level to within 0.25 m (10 in.) of the tank sludge level. The pump inlet height will be adjustable while pumping. The inlet height will be controlled to minimize entrainment and pickup of solids in the decanted liquid. The decant transfer pump will not be used during mixer pump operation and it will be designed so that it is not damaged by mixer pump operation. The transfer system will be instrumented for flow, pressure, density, viscosity, and turbidity as well as appropriate motor control instrumentation.

(2) **Add Sludge Wash Solution.** Add heated sludge wash solution to the slurry in 241-AZ-101. The wash solution (2*M*, 0.32*M* NaOH and raw water for the first, second, and third washes respectively) is added in a 3:4, 5:4, and 5:4 (for the first, second, and third washes respectively) dilution ratio with the settled solids volume. Wash solutions will be added through a nozzle in a tank riser and will dump into the vapor space. Alternatively, an "enhanced" sludge washing solution may be used to remove additional aluminum from the sludge. The enhanced sludge washing will be performed by adding a more concentrated NaOH solution. The washing will be enhanced by heating the slurry, through mixer pump operation, and use of preheated wash solution.

(3) **Mix Feed.** Mix the tank contents using the mixer pumps, which also adds heat to the slurry. This activity is assumed to take 5 days, at which time the slurry is at 80 °C.

(4) **Take Process Control Samples.** Process control samples are assumed to be three grab samples taken at different depths from a single riser. Samples are taken as soon as possible after the mixer pumps are turned off. The sample results are used to evaluate progress of the sludge washing and analyze for key parameters that are identified as

"borderline" with respect to Envelope D. Decisions to be made are whether to proceed with feed qualification sampling, decant a portion or all of the wash liquor, perform another sludge washing cycle, or adjust the feed composition to maintain the feed within Envelope D.

(5) **Analyze Process Control Samples.** The laboratory analyses are assumed to take 2 weeks to complete and report. Analyses will likely include inductively coupled plasma (ICP) and ion chromatography (IC) analysis of dissolved solids, bulk density, pH, and % solids.

(6) **Evaluate Sample Data.** If the samples indicate that the sludge may not be within specification, evaluate options for further pretreatment. Modeling may be used to evaluate the effectiveness of further pretreatment. Pretreatment options include further sludge washing, adjusting the feed by adding glass formers such as SiO_2 and/or NaO. Blending with sludge from another double-shell tank (DST) is also possible depending on the availability of a retrieval system in the other DST.

(7) **Settle Solids.** The mixer pumps were turned off to allow process control sampling (step 4). The solids are allowed to settle prior to further processing. The progress of the solids settling will be monitored using ultrasonic interface level analyzers (URSILLA) and/or gamma profiles in drywells. Settling is assumed to require 30 days.

(8) **Decant Supernate.** Decant the supernate (wash solution) to the appropriate storage DST. The supernate from 241-AZ-101 is transferred to tank 241-AW-105 (this is the current tank, but that may change). This activity is the same as step 1 and would be controlled similarly.

The planned number of sludge washing cycles are three for 241-AZ-101. Each sludge wash cycle is a repeat of steps 2-8.

(9) **Adjust Feed (Optional).** If selected in step 6 and approved by DOE, adjust the feed by chemical shimming or blending.

(10) **Add Transfer Solution.** An inhibited-water solution is added to 241-AZ-101 to dilute the solids so the slurry concentration is between 25 g/L and 100 g/L waste oxides. This dilution should meet waste transfer requirements.

(11) **Mix Feed.** The mixer pumps are used to mix the slurry in 241-AZ-101. This step should be relatively quick; requiring a few hours to a few days of mixing.

(12) **Sample Staged Feed.** Feed qualification sampling will be covered in *Data Quality Objectives for TWRS Privatization Phase 1: High-Level Waste Feed Delivery Transfer to Private Contractors* (PSDQO-10) (Crawford 1998).

Define the waste that applies to each element in the decision rule.

Element 1, Envelope Requirements (Composition and Physical Properties): the waste to be used to provide Batches 1 and 2 is pretreated sludge from tank 241-AZ-101. The envelope limits apply to each batch transferred to the private contractor (solids and liquid). The waste currently residing in tank 241-AZ-101 has not been pretreated, and also contains supernatant which will be used for LAW Envelope B feed. The Envelope B feed must be separated from the sludge prior to pretreatment and staged into tank 241-AY-101. The ability to comply with the Waste Envelope D feed specifications is based on projections, using sample and process test data.

Element 2, Quantity Requirements: This requirement applies to the size of each batch of HLW feed (mass of non-volatile oxides excluding sodium and silicon) delivered from 241-AZ-101 to the Privatization Contractor.

Element 3, Pretreatment Process Chemistry Requirements: These requirements apply to the equilibrium distribution of chemical species (i.e., the contract envelope analytes) between the solid and liquid phases, contact time and temperature required to achieve chemical equilibrium, and determination of the number and type of sludge washes required to make desired feed.

Element 4, Transfer Requirements: Transfer requirements apply to a whole tank composite of the waste in 241-AZ-101 after pretreatment and after the addition of transfer solution.

Element 5, Miscellaneous Inputs: These inputs apply to the whole tank composition of 241-AZ-101 or to changes in the operating scenario that may be imposed in the future.

Evaluate existing data and determine information needs.

Table 1 contains what data are available and needed to establish that 241-AZ-101 is appropriate for meeting Envelope D feed requirements. The elements for making this determination are found in Section 6 of the PSDQO for Confirm Tank T for HLW. The information needs are summarized in Table 2.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 1- Envelope Requirements These limits apply to the feed actually delivered to the private contractors.	Concentration limits for the chemical and physical and radionuclide content of the feed (DOE-RL 1996, Section C-6, Spec. 8).	Concentration limits for the non-volatile elements, volatile components, and radionuclides in the feed. The ability to satisfy the current Waste Envelope D specifications is strongly dependent upon the effectiveness and controllability of the pretreatment process. Existing sludge wash data was based on a composite of AZ-101 and AZ-102 sludge, and therefore, is not sufficient to confirm that the existing feed specifications can be satisfied if treating AZ-101 alone. The TWRSO&UP (Kirkbride et al. 1997) indicates that the concentration of aluminum will be above the Waste Envelope D specifications if water-washed, but low in Al, high in Fe and Mn if 99% of the Al is caustic leached. The TWRSO&UP suggests that the aluminum concentration can be brought within the specifications if leached with more dilute caustic solution. However, such a process has to be verified by sludge wash testing. An optimized pretreatment scenario has been developed using existing data and Environmental Simulation Program (ESP). This information will be used to determine when there has been sufficient sludge washes. At that point, analyses of the sludge are done to confirm that Waste Envelope D chemical and radiochemical specifications are met. Physical property limits for the feed Physical property values are either missing from existing characterization data or not estimated from expected compositions resulting from sludge washing. Measurements of these properties will need to be made on the pretreated sludge obtained during process testing. These measurements should be made only after determination of the desired sludge washes to meet the chemical specifications in Waste Envelope D and at the proposed operating concentrations (i.e., 100 gm/L non-volatile oxides [NVO]). Some of the Waste Envelope D physical properties will be determined by calculation (DOE-RL 1996). The Management and Integration (M&I) Contractor will specify methods for the elements, components, isotopes, and physical properties. RL approval of the methods will be required prior to performing the measurements.	Perform process test on representative composite sample of sludge from 241-AZ-101 to address issues raised in discussion/evaluation portion of Table 1. Analysis of sludge will be done after appropriate sludge washes to determine the minimum number of sludge washes required to meet Envelope D chemical, physical and radiochemical specifications. See Element 3- Pretreatment for details on obtaining samples for analysis elements, components, isotopes, and physical properties Specify methods and obtain RL approval.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 2-Quantity Requirements	Batch size constraint (from the contracts [DOE-RL 1996]) ≥ 5 MT Mass of non-volatile oxides excluding sodium and silicon	Contract Batch Size Requirement The current inventory of 241-AZ-101 indicates approximately 96.4 MT of HLW feed. The mixer pumps are expected to be capable of mobilizing 90 percent of the waste in 241-AZ-101. Therefore, the requirement of a minimum of 5 MT of HLW feed for the initial batch can be met. PHMC Targeted Batch Size Assuming the Privatization contractor has the capacity to receive a maximum batch of 587 kL (155 kgal), plus two line volumes of flush solution estimated to be 60 kL (13 kgal) the PHMC intends to deliver that HLW feed at the maximum concentration (subject to waste transfer system limitations) of 100 g NVO/L. A measurement of the sludge fraction mobilized in 241-AZ-101 is needed during the W-151 mixer pump test. This test will verify that at least 90 percent of the sludge can be mobilized. To obtain this concentration, the slurry concentration will have to be diluted. There should be no dilution difficulties (See Element 4 below). Based on this concentration, the pretreated sludge 241-AZ-101 can be delivered in 2 equal sized batches of 43.4 MT, which is much higher than the 5 MT minimum initial batch size.	Expectation is that there will be no difficulty in achieving the desired 1,100 g NVO/L slurry concentration.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 3-Pretreatment Process Chemistry Requirements	Type and number of sludge washes to meet Waste Envelope D specifications	Confirmation the equilibrium distribution of chemical species Current estimates of the HLW feed composition are projections based on available process test and characterization data. Since the process tests were conducted at different conditions for sludge washing, and the projections are based only a theoretical chemical equilibrium models (i.e., ESP), process test with representative samples is required. The objectives of such a test are to determine the range of process parameters (e.g., temperature, volume/concentration caustic, number of wash cycles, mixing time to reach equilibrium, settling time), and efficiency in dissolution that would ensure compliance with Waste Envelope D specifications in the pretreated sludge product. Based on Best-Basis Inventory (BBI) and ESP, sulfate needs to be removed from interstitial fluid by washing to meet Waste Envelope D specifications. Current estimates are that 3 washes are needed. If there is more solid sulfate than expected, then removing sulfate to meet the Waste Envelope D requirements need to be rethought. In process testing, determine the rate of solids dissolution for comparison with process time allotted. Determine if caustic leaching is required to remove sufficient aluminum. A process test is needed to verify the amount of aluminum A1 (and other minor species) leached (dissolved) from the solids. This is required, because, some degree of aluminum removal is required (based on the TWRSO&UP), but not too much. Too much removal could create problems with other cations (e.g., Fe) that could limit the waste oxide loading. Current estimates of the amount of A1 removal are based on limited process test data, and chemical equilibrium models. Data need to be obtained to support carrying out an alternatives generation and analysis (AGA) to determine how much A1 can be removed before another cation limits the waste oxide loading. Also, establish the amount of supernate to leave behind so the nitrate can enhance the ionic strength of solution allowing more A1 to dissolve.	Perform process test on representative composite sample of sludge from 241-AZ-101 to address issues raised in discussion/evaluation portion of Table1.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 3-Pretreatment Process Chemistry Requirements (continued)	Type and number of sludge washes to meet Waste Envelope D specifications (continued)	(Continued) By adding Na as NaOH in the caustic leaching step, Mg and Ca will likely be outside the Waste Envelope D requirements. Sludge washes with "clean" water are required to remove the added Na and to remove additional Al from the interstitial fluid so Na will meet Waste Envelope D specifications. These should be all the chemical issues related to waste processing. 241-AZ-101 should meet all other Waste Envelope D chemical and radiochemical requirements. The potential also exists for poor settling due to the formation of gels. An operating range for the process parameters needs to be determined, to avoid gel formation. Confirmation that the undissolved solids settle and that they settle in a reasonable amount of time. Existing settling rate data are based on laboratory, scale testing, with limited applicability, due to wall effects in smaller vessels. The settling rates need to be measured in a bench-scale settling column, to eliminate the wall effects, in order to design the necessary equipment and to allocate the appropriate amount of time required for waste feed processing. Settling tests in 241-AZ-101 will be performed as part of the W-151 mixer pump tests. But, these tests may be complicated by the existing supernate. Hence, the Waste Retrieval Program staff must determine the need for bench-scale settling tests. Confirmation that the baseline retrieval equipment that will be used to mobilize the waste will work as planned.	

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 4-Transfer Requirements	Confirm that the as-retrieved waste remains at or below viscosity of 10 cP, at or below a 1.5 SpG, and at or below 30 percent solids by volume during the transfer to the private contractor. Confirm that the selected dilution ratio using inhibited water will not form gibbsite or cause components in the slurry to precipitate during the transfer.	There are limited data for estimating that: 1) pretreated waste (i.e., after sludge washing) will conform to the physical measurements around which the transfer process was designed, 2) the waste feed will remain within the Waste Envelope D during transfer, 3) the dilution ratio will not cause excessive gels and other precipitates to form in the transfer system.	During process test, upon completion of the desired type and number of sludge washes, obtain the pretreated sludge sample from 241-AZ-101 to make the required measurements.
Element 5-Miscellaneous Requirements	Physical form of Tank 241-AZ-101 contents. Shimming Batches 1 and 2 RL direction	From Hodgson (1995), 241-AZ-101 consists of compositionally homogenous supernate of approximately 3,630 KL, a layer of soft sludge of approximately 175 KL. There is no heel/hard pan. No shimming is anticipated. No changes to applicable M&I ICD requirements have been made to date.	No further information is needed. No further information is needed. No further information is needed at this time.

Table 2. Summary of Information Needs. (2 Sheets)

Elements	Information needed	Planned resolution	Sample required
Element 1- Envelope Requirements	Upon performing the desired type and number of sludge washes, perform analyses on the resulting sludge to confirm that Waste Envelope D specifications will likely be met with 241-AZ-101 contents.	After process testing, analyze the sludge washed sample for the Waste Envelope D specifications.	300 gm samples taken from Element 3.
Element 2- Quantity Requirements	Measurement of sludge fraction mobilized.	After mixer pump operation and full suspension of 241-AZ-101 solids, analyze samples to determine percent solids, particle density, and chemical composition as function of height in mixed slurry.	100 ml of 241-AZ-101 slurry each from 10 heights in tank.
Element 3- Pretreatment Process Chemistry Requirements	- process parameters for carrying out each sludge wash cycle including time versus temperature to reach chemical equilibrium, ionic strength, and hydroxide concentration. - confirm equilibrium distribution of chemical species - optimal amount of Al in supernate - optimal amount of Al, Fe, and Mn left in sludge - optimal amount of Na removed - settling tests after washing - number of washes to bring SO_4 into specification - balance optimal amounts above with estimate of waste oxide loadings that would result.	Perform process testing to establish type and number of sludge washes.	Solids fraction of slurry samples taken in Element 2.

Table 2. Summary of Information Needs. (2 Sheets)

Element 4- Transfer Requirements	Confirm that waste meets transfer requirements.	During process test, confirm that supernate and slurry meet viscosity, SpG, percent solids, transfer requirements. Confirm that remain within Envelope D physical properties during transfer.	Performed as part of process test for Element 3, above.
Element 5- Miscellaneous Requirements	No new information needed.	No new information needed.	No new information needed.

3.0 REFERENCES

Crawford, T. W., R. D. Schreiber, J. Jo, and A. F. Manuel (VECO), 1998, *Data Quality Objectives for TWRS Privatization Phase 1: Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X,* HNF-1558 (PSDQO-02), Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

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ADDENDUM 2

APPLICATION OF

"CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X"

TO

241-AZ-102 / BATCHES 3, 4, 5, AND 6

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CONTENTS

LIST OF TABLES

LIST OF TERMS

AGA	Alternatives generation and analysis
C	centigrade
DOE-RL	U.S. Department of Energy-Richland Operation
DST	Double-shell tank
ESP	Environmental Simulation Program
HLW	High-Level Waste
IC	Ion chromatography
ICP	Inductively coupled plasma
LAW	Low-Activity Waste
M	Molar (gmoles/liter)
M&I	Management and Integration
NVO	non-volatile oxides
PHMC	Project Hanford Management Contract(or)
PMBS	Project Master Baseline Schedule
PSDQO	Problem-Specific Data Quality Objectives
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TANK T	Refers to the contents from one tank, multiple tanks, or portions of one or more tanks that will be used to prepare a feed batch
TOC	Total Organic Carbon
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
URSILLA	Ultrasonic interface level analyzers
USQ	Unreviewed Safety Question
WIT	Waste Disposal Integration Team

APPLICATION OF "CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR HIGH-LEVEL WASTE FEED BATCH X" TO 241-AZ-102 / BATCHES 3, 4, 5, AND 6

1.0 INTRODUCTION

This addendum applies Revision 0 of "Confirm Tank T is an Appropriate Feed Source for High-Level Waste Feed Batch X" problem-specific data quality objectives (PSDQO) to tank 241-AZ-102 / Batches 3, 4, 5, and 6.

This application of PSDQO-02 describes the Base Case Operating Scenario, which pretreats the waste in tank 241-AZ-102 prior to transfer to the Privatization Contractor.

There is one base case operating scenario for 241-AZ-102 whose elements are described. Table 1 in Section 2.0 contains information specific to 241-AZ-102 addressing all elements in Section 6 of the PSDQO on Confirm Tank T for HLW. Table 2 in Section 2.0 contains specific new data required by the waste feed delivery program to confirm that 241-AZ-102 is an appropriate feed source.

2.0 EVALUATION

2.1 BASE CASE OPERATING SCENARIO

Translate the operating scenario into a series of process steps.

The base case operating scenario from the *Waste Feed Delivery Technical Basis, Volume II, Waste Feed Delivery Flowsheet* (Papp 1998) includes the following steps to make up Batches 3, 4, 5 and 6:

Step Description

(1) **Decant Initial Supernate.** Decant the supernate to the appropriate DST. The supernate from 241-AZ-102 will be transferred to 241-AY-101. The solids content will be monitored using a turbidity meter or other in-line instrument. Stop the decant when the solids content reaches a predefined limit, indicating that the supernate/settled solids interface has been reached.

The decant transfer pump will be capable of decanting liquid with a variable depth inlet which is adjustable from the tank's maximum operating level to within 0.25 m (10 in.) of the tank sludge level. The pump inlet height will be adjustable while pumping. The inlet height will be controlled to minimize entrainment and pickup of solids in the decanted liquid. The decant transfer pump will not be used during mixer pump operation and it will be designed so that it is not damaged by mixer pump operation. The transfer system will be instrumented for flow, pressure, density, viscosity, and turbidity as well as appropriate motor control instrumentation.

(2) **Add Sludge Wash Solution.** Add heated sludge wash solution to the slurry in 241-AZ-102. The wash solution (2*M*, 0.32*M* NaOH and raw water) is added in a 3:4, 5:4, and 5:4 dilution ratio (for the first, second, and third washes respectively) with the settled solids volume. Wash solutions will be added through a nozzle in a tank riser and will dump into the vapor space. Alternatively, an "enhanced" sludge washing solution may be used to remove additional aluminum from the sludge. The enhanced sludge washing will be performed by adding a more concentrated NaOH solution. The washing will be enhanced by heating the slurry, through mixer pump operation, and use of preheated wash solution.

(3) **Mix Feed.** Mix the tank contents using the mixer pumps, which also adds heat to the slurry. This activity is assumed to take 5 days, at which time the slurry is at 80 °C.

(4) **Take Process Control Samples.** Process control samples are assumed to be three grab samples taken at different depths from a single riser. Samples are taken as soon as possible after the mixer pumps are turned off. The sample results are used to evaluate progress of the sludge washing and analyze for key parameters that are identified as

"borderline" with respect to Envelope D. Decisions to be made are whether to proceed with feed qualification sampling, decant a portion or all of the wash liquor, perform another sludge washing cycle, or adjust the feed composition to maintain the feed within Envelope D.

(5) **Analyze Process Control Samples.** The laboratory analyses are assumed to take 2 weeks to complete and report. Analyses will likely include inductively coupled plasma (ICP) and ion chromatography (IC) analysis, dissolved solids, bulk density, pH, and % solids.

(6) **Evaluate Sample Data.** If the samples indicate the sludge may not be within specification, evaluate options for further pretreatment. Modeling may be used to evaluate the effectiveness of further pretreatment. Pretreatment options include further sludge washing, adjusting the feed by adding glass formers such as SiO_2 and/or NaO. Blending with sludge from another double-shell tank (DST) is also possible depending on the availability of a retrieval system in the other DST.

(7) **Settle Solids.** The mixer pumps were turned off to allow process control sampling (step 4). The solids are allowed to settle prior to further processing. The progress of the solids settling will be monitored using ultrasonic interface level analyzers (URSILLA) and/or gamma profiles in drywells. Settling is assumed to require 30 days.

(8) **Decant Supernate.** Decant the supernate (wash solution) to the appropriate storage DST. The supernate from 241-AZ-102 is transferred to tank 241-AN-105 (this is the current tank, but that may change). This activity is similar to step 1 and would be controlled similarly.

The planned number of sludge washing cycles are three for 241-AZ-102. Each sludge wash cycle is a repeat of steps 2-8.

(9) **Adjust Feed (Optional).** If selected in step 6 and approved by DOE, adjust the feed by chemical shimming or blending.

(10) **Add Transfer Solution.** An inhibited-water solution is added to 241-AZ-102 to dilute the solids so the slurry concentration is between 25 g/L and 100 g/L waste oxides. This dilution should meet waste transfer requirements.

(11) **Mix Feed.** The mixer pumps are used to mix the slurry in 241-AZ-102. This step should be relatively quick; requiring a few hours to a few days of mixing.

(12) **Sample Staged Feed.** Feed qualification sampling will be discussed in *Data Quality Objectives for TWRS Privatization Phase 1: High-Level Waste Feed Delivery Transfer to Private Contractors* (PSDQO-10) (Crawford 1998).

Define the waste that applies to each element in the decision rule.

Element 1, Envelope Requirements (Composition and Physical Properties): the waste used to provide Batches 3, 4, 5, and 6 is pretreated sludge from tank 241-AZ-102. The envelope limits apply to each batch transferred to the private contractor (solids and liquid). The waste currently residing in tank 241-AZ-102 has not been pretreated, and also contains supernatant which will be used for LAW Envelope B feed. The Envelope B feed must be separated from the sludge prior to pretreatment and staged into tank 241-AY-101. The ability to comply with the Waste Envelope D feed specifications is based on projections, using sample and process test data.

Element 2, Quantity Requirements: This requirement applies to the size of each batch of HLW feed (mass of non-volatile oxides excluding sodium and silicon) delivered from 241-AZ-102 to the Privatization Contractor.

Element 3, Pretreatment Process Chemistry Requirements: These requirements apply to the equilibrium distribution of chemical species (i.e., the contract envelope analytes) between the solid and liquid phases, contact time and temperature required to achieve chemical equilibrium, and determination of the number and type of sludge washes required to make desired feed.

Element 4, Transfer Requirements: Transfer requirements apply to a whole tank composite of the waste in 241-AZ-102 after pretreatment and after the addition of transfer solution.

Element 5, Miscellaneous Inputs: These inputs apply to the whole tank composition of 241-AZ-101 or to changes in the operating scenario that may be imposed in the future.

Evaluate existing data and determine information needs.

Table 1 contains what data are available and needed to establish 241-AZ-102 as appropriate for meeting Envelope D feed requirements. The elements for making this determination are found in Section 6 of the PSDQO for Confirm Tank T for HLW. The information needs are summarized in Table 2.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 1- Envelope Requirements These limits apply to the feed actually delivered to the private contractors.	Concentration limits for the chemical, physical, and radionuclide content of the feed (DOE-RL1996, Section C-6, Spec. 8).	Concentration limits for the non-volatile elements, volatile components, and radionuclides in the feed. The ability to satisfy the current Waste Envelope D specifications is strongly dependent upon the effectiveness and controllability of the pretreatment process. Existing sludge wash data was based on a composite of AZ-101 and AZ-102 sludge (Rapko and Wagner 1997), and therefore, is not sufficient to confirm that the existing feed specifications can be satisfied if treating AZ-102 alone. The TWRSO&UP (Kirkbride et al. 1997) indicates that the concentration of aluminum will be above and the sodium will be below the Waste Envelope D specifications if water-washed, but low in Al and Na, high in Fe and Ni if 99% of the Al is caustic leached. The aluminum concentration can be reduced by dissolving some of the aluminum with a small amounts of caustic solution. This addition of caustic solution will also increase the sodium concentration so that it will be within the specifications. However, the addition of caustic process has to be verified by sludge wash testing. An optimized pretreatment scenario has been developed using existing data and environmental simulation program (ESP). This information will be used to determine when there has been sufficient sludge washes. At that point, analyses of the sludge are done to confirm that Waste Envelope D chemical and radiochemical specifications are met. Physical property limits for the feed Physical property values are either missing from existing characterization data or not estimated from expected compositions resulting from sludge washing. Measurements of these properties will need to be made on the pretreated sludge obtained during process testing. These measurements should be made only after determination of the desired sludge washes to meet the chemical specifications in Waste Envelope D and at the proposed operating concentrations (i.e., 100 gm/L non-volatile oxides [NVO]). Some of the Waste Envelope D physical properties will be determined by calculation. The Management and Integration (M&I) Contractor will specify methods for the elements, components, isotopes, and physical properties. RL approval of the methods will be required prior to performing the measurements.	Perform process test on representative composite sample of sludge from 241-AZ-102 to address issues raised in discussion/evaluation portion of Table 1. Analysis of sludge will be done after appropriate sludge washes to determine the minimum number of sludge washes required to meet Envelope D chemical , physical and radiochemical specifications. See Element 3- Pretreatment for details on obtaining samples for analysis elements, components, isotopes, and physical properties such as viscosity, yield stress, shear strength, and heat capacity. Specify methods and obtain RL approval.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 2-Quantity Requirements	Batch size constraint (from the contracts [DOE-RL 1996]) ≥ 5 MT Mass of non-volatile oxides excluding sodium and silicon	Contract Batch Size Requirement The current inventory of 241-AZ-102 indicates approximately 160 MT of HLW feed. The mixer pumps are expected to be capable of mobilizing 60 percent of the waste in 241-AZ-102. Therefore, the requirement of a minimum of 5 MT of HLW feed for the initial batch can be met. PHMC Targeted Batch Size Assuming the Privatization contractor has the capacity to receive a maximum batch of 587 kL (155 kgal) plus four flush solution estimated to be 60 kL (13 kgal), the PHMC intends to deliver that HLW feed at the maximum concentration (subject to waste transfer system limitations) of 100 g NVO/L. Based on this concentration, the pretreated sludge 241-AZ-102 can be delivered in 4 equal sized batches of 24 MT, which is much higher than the 5 MT minimum initial batch size.	Expectation is that there will be no difficulty in achieving the desired 100 g NVO/L slurry concentration.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 3-Pretreatment Process Chemistry Requirements	Type and number of sludge washes to meet Waste Envelope D specifications	Confirm the equilibrium distribution of chemical species Current estimates of the HLW feed composition are projections based on available process test and characterization data. Since the process tests were conducted at different conditions for sludge washing, and the projections are based only on theoretical chemical equilibrium models (i.e., ESP), process tests with representative samples is required. The objectives of such a test are to determine the range of process parameters (e.g., temperature, volume/concentration caustic, number of wash cycles, mixing time to reach equilibrium, settling time), and efficiency in dissolution that would ensure compliance with Waste Envelope D specifications in the pretreated sludge product. In process testing, determine the rate of solids dissolution for comparison with process time allotted. Determine if caustic leaching is required to remove sufficient aluminum. A process test is needed to verify the amount of aluminum Al (and other minor species) leached (dissolved) from the solids. This is required, because, some degree of aluminum removal is required (based on the TWRSO&UP), but not too much. Too much removal could create problems with other cations (e.g., Fe) that could limit the waste oxide loading. Current estimates of the amount of Al removal are based on limited process test data, and chemical equilibrium models. Data will need to be obtained to support carrying out an alternatives generation and analysis (AGA) to determine how much Al can be removed before another cation limits the waste oxide loading. Also, establish the amount of supernate to leave behind so the nitrate can enhance the ionic strength of solution allowing more Al to dissolve. A process test is needed to verify the amount of Na to be added during the caustic leaching. This addition of caustic solution will also increase the sodium concentration .	Perform process test on representative composite sample of sludge from 241-AZ-102 to address issues raised in the discussion/evaluation portion of Table 1.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 3-Pretreatment Process Chemistry Requirements (continued)	Type and number of sludge washes to meet Waste Envelope D specifications (continued)	(Continued) These should be all the chemical issues related to waste processing. 241-AZ-102 should meet all other Waste Envelope D chemical and radiochemical requirements. The potential also exists for poor settling due to the formation of gels. An operating range for the process parameters needs to be determined, to avoid gel formation. Confirmation that the undissolved solids settle and that they settle in a reasonable amount of time. Settling rate data are needed on laboratory scale test for AZ-102. The settling rates will be measured in a bench-scale settling column for AZ-101. This data can be compared with the data from laboratory scale test of AZ-102 to estimate the appropriate amount of time required for waste feed processing. Confirmation that the baseline retrieval equipment used to mobilize the waste will work as planned.	
Element 4-Transfer Requirements	Confirm that the as-retrieved waste remains at or below viscosity of 10 cP, at or below a 1.5 SpG, and at or below 30 percent solids by volume during the transfer to the private contractor. Confirm that the selected dilution ratio using inhibited water will not form gibbsite or cause components in the slurry to precipitate during the transfer.	There are limited data for estimating that: 1) pretreated waste (i.e., after sludge washing) will conform to the physical measurements around which the transfer process was designed, 2) the waste feed will remain within the Waste Envelope D during transfer, 3) the dilution ratio will not cause excessive gels and other precipitates to form in the transfer system.	Upon completion of the desired type and number of sludge washes, obtain the pretreated sludge sample from 241-AZ-102 to make the required measurements.

Table 1. Evaluation of the Base Case Operating Scenario. (5 Sheets)

Element	Requirements	Discussion/evaluation	Information needs
Element 5-Miscellaneous Requirements	Physical form of Tank 241-AZ-102 contents.	241-AZ-102 consists of homogenous supernate of approximately 2,940 KL, a layer of soft sludge of approximately 394 kL. There is no heel/hard pan.	No further information is needed.
		No shimming is anticipated.	
	Shimming Batches 3 and 4		No further information is needed.
		No changes to applicable interface control document requirements have been made to date.	
	RL direction		No further information is needed at this time.

Table 2. Summary of Information Needs.

Elements	Information needed	Planned resolution	Sample required
Element 1- Envelope Requirements	Upon performing the desired type and number of sludge washes, perform analyses on the resulting sludge to confirm that Waste Envelope D specifications will likely be met with 241-AZ-102 contents.	After process testing, analyze the sludge washed sample for the Waste Envelope D specifications.	80 gm of sludge washed sample; 40 gm of original 241-AZ-102 sludge composite.
Element 2- Quantity Requirements	Measurement of sludge fraction mobilized.	After mixer pump operation and full suspension of 241-AZ-102 solids, analyze samples to determine percent solids, particle density, and chemical composition as a function of height in mixed slurry.	80 ml of 241-AZ-102 slurry from 5 heights in tank.
Element 3- Pretreatment Process Chemistry Requirements	- process parameters for carrying out each sludge wash cycle including time versus temperature to reach chemical equilibrium, ionic strength, and hydroxide concentration. - confirm equilibrium distribution of chemical species - amount of Al in supernate - amount of Al, Fe, Na, and Ni left in sludge - amount of Na removed - Na added in caustic leach - settling tests after washing	Perform process testing to establish type and number of sludge washes.	100 gm of sludge washed sample 250 gm of original 241-AZ-102 sludge
Element 4- Transfer Requirements	Confirm that waste meets transfer requirements.	During process test, confirm that supernate and slurry meet viscosity, SpG, percent solids, transfer requirements. Confirm that remain within Envelope D physical properties during transfer.	Performed as part of process test for Element 3, above.
Element 5- Miscellaneous Requirements	No new information needed.	No new information needed.	No new information needed.

3.0 REFERENCES

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