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DISPOSITION COMMENT

Although this document (HNF-1796) can be used to prepare a tank sampling and analysis plan, HNF-1796 does not currently follow the same format as the Data Quality Objective (DQO) documents produced by the Tank Waste Remediation System (TWRS) in the past. The TWRS format, along with the organization of the data input requirements, had the acceptance of RL and Ecology. Section 4.0 (step 3 of the DQO process) in the TWRS format is the location for data inputs and requirements instead of a separate addendum. The document should be written so it could apply to all tanks that fall within the scope of HNF-1796, without the necessity for a separate addendum/DQO for each tank. In addition, HNF-1796 contains extraneous material not needed in a DQO.

HNF-1796 is approved on the condition that when a major revision (e.g. new data requirements, new scope, new boundaries, etc.) to the document is required, it will be written in the format used in previous TWRS DQOs.

J. G. Kristofzski

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HNF-1796, Rev. 0
PSDQO-01

Data Quality Objectives for TWRS Privatization Phase I: Confirm Tank T is an Appropriate Feed Source for Low-Activity Waste Feed Batch X

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Abstract: This document is one of a series of problem-specific data quality objectives prepared to help identify information needs of Tank Waste Disposal in support of the Phase I Privatization of the Tank Waste Remediation System (TWRS).

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DATA QUALITY OBJECTIVES FOR TWRS PRIVATIZATION PHASE I: CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR LOW-ACTIVITY WASTE FEED BATCH X

January 1998

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Prepared for
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CONTENTS

LIST OF TERMS

ANOVA	Analysis of Variance
DOE	U.S. Department of Energy
ICD	Interface Control Document
LAW	Low-Activity Waste
M	Molar (gmoles/liter)
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
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
TSAP	Tank Sampling and Analysis Plan
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
USQ	Unreviewed Safety Question
WIT	Waste Disposal Integration Team

DATA QUALITY OBJECTIVES FOR TWRS PRIVATIZATION PHASE I: CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR LOW-ACTIVITY WASTE FEED BATCH X

1.0 INTRODUCTION

1.1 BACKGROUND

The Phase I privatization contracts require that the Project Hanford Management Contractors (PHMC), on behalf of the U.S. Department of Energy-Richland Operations (RL), deliver the appropriate quantities of the proper composition of feed on schedule to the Privatization Contractors (DOE-RL 1996). The type of feed needed, the amount of feed needed, and overall timing of when feed is to be delivered to the privatization contractor are specified by these contracts. Additional requirements are imposed by the interface control document (ICD) for low-activity waste (LAW) Feed (PHMC 1997).

The Tank Waste Remediation System Operation and Utilization Plan (TWRSO&UP) establishes the baseline operating scenario for the delivery of feed to two Privatization Contractors (Kirkbride et al. 1997). The project master baseline schedule (PMBS) and corresponding logic diagrams that will be used to implement the operating scenario have been developed and are currently being refined.

The baseline operating scenario in the TWRSO&UP specifies which tanks will be used to provide feed for each specific feed batch, the operational activities needed to prepare and deliver each feed batch, and the timing of these activities. This operating scenario has considered such factors as the privatization contracts and ICD requirements, waste composition and chemistry, equipment availability, project schedules and funding, tank farm logistics, and the availability of tank space.

The PMBS includes activities to reduce programmatic risk. The purpose of one of these activities, "Confirm Plans and Requirements," is to confirm that the proper trade-offs (in the factors listed in the above paragraph) were made in developing the operating scenario for each and every feed batch and to verify that there are no other reasons (in the equipment design, process control, safety or permitting areas) to reject the baseline plans for the feed batch under consideration. The "Confirm Plans and Requirements" activity will follow the TWRS decision management process (WHC 1996).

One of the inputs to the "Confirm Plans and Requirements" decision is to confirm that the proposed feed source(s) are appropriate for a specific batch in terms of composition, quantity and transfer properties. This is the subject of this problem-specific data quality objectives (PSDQO) document.

1.2 APPROACH

The Tank Waste Retrieval Division has determined that a strategic and cost-effective way to identify the data needed for Phase IB waste feed delivery is to define those data needs on a batch-by-batch basis using the DQO process. Key questions were identified during preparation of the TWRSO&UP; the ICDs (Berry 1997); trade-studies and decision reports; by project engineers; and by the various subject matter experts in operations, maintenance, equipment design, process control, chemistry, process design, safety and permitting who are working on refining the PMBS. These key questions (for example, Confirming that Tank T is appropriate for LAW feed batch X) were then assigned to a set of problem-specific DQOs; the PSDQO covers all the basic issues associated with resolving that key-question.

The current operating scenario delivers 12 batches of LAW feed to each of two LAW contractors and 12 batches of HLW feed to the HLW contractor.[1] There currently are plans for 12 PSDQO that support Phase IB waste feed delivery. If individual PSDQO were written for each valid combination of key questions and feed batches, the number of PSDQOs could exceed 300. Tank Waste Retrieval determined that preparing template PSDQO that cover all the basic issues associated with resolving each key question would help maintain a tractable work scope.

Each template PSDQO contains the strategic thoughts, requirements and decision rules for resolution of the key question. For each batch, the Tank Waste Retrieval Division, with assistance from TWRS Characterization, will walk through each basic issue in the template PSDQO (i.e., apply the PSDQO to a specific batch) to either:

- Answer the issue that was raised in the template PSDQO, or[2]
- Identify missing information that is needed to answer the issue.

The results of applying the PSDQO to a specific batch will be documented in an addendum to the PSDQO and will become the technical direction needed by TWRS Characterization and the organization performing the process test, if any. If there are unsatisfied information needs, TWRS Characterization will prepare a Tank Sampling and Analysis Plan (TSAP) or a letter of instruction in lieu of a TSAP to do the following:

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[1]It is by coincidence that the number of LAW and HLW feed batches are the same.

[2]Taken together, the template PSDQO and its application to a specific batch will identify all the information needed to answer each issue, and be the input information required to prepare a "tank sampling and analysis plan."

- Request statistical analysis or historical review of existing characterization data to see if the needed information is already available.

- Request further analysis of existing sample material.

- Request sample material.

If a process test is required, the Tank Waste Retrieval Division will do the following:

- Request that a process test be performed.

Once the needed information has been obtained by TWRS Characterization or the organization performing the process test, the Tank Waste Retrieval Division will finish their evaluation of the issues and make a decision.

The end user of the template PSDQO is the Tank Waste Retrieval Division, while the end user of applying the PSDQO to a specific batch when new characterization or process data are required is Tank Waste Remediation System (TWRS) Characterization or the organization performing the process test.

2.0 STEP 1--STATEMENT OF THE PROBLEM

As part of the high-level waste tank remediation program, specific tanks, in a specific sequence, need to be staged for delivery of feed to the private contractor. The selection of the tank, or group of tanks, is subject to the following so waste can be removed and transferred:

1. The type of feed (chemical nature) and the amount of feed needed at a specific time by the private contractor.

2. The physical composition of the waste feed to assure that the waste can be removed and transferred.

Before focusing on the confirmation that Tank T[1] is appropriate for Batch X, other efforts[2] have transpired that used best-basis inventory estimates, and balanced other factors to determine that Tank T is likely to be appropriate to deliver the right type, composition and quantity of feed, on time. If there were several other tanks or combinations of tanks that could meet the feed and equipment requirements, this effort resulted in the selection of Tank T as appropriate feed for Batch X. This PSDQO focuses on the activities needed to confirm that Tank T is appropriate in terms of composition, quantity, and ability to be transferred.

This PSDQO needs to be applied so that a specific feed source tank (T) can be confirmed to have the desired chemical and physical properties to support the "Confirm Plans and Requirements" activity in the PMBS for the specific feed batch under consideration (Batch X).

[1]"Tank T" refers to the contents from one tank, multiple tanks, or portions of one or more tanks that may be used to prepare a given feed batch.

[2]The effort is documented in the TWRSO&UP.

3.0 STEP 2--IDENTIFY THE DECISION

Is the waste in Tank T[1] appropriate for use as source material for the makeup of Low-Activity Waste Feed Batch X?

The specific sub-questions that must be answered in order to make the decision are as follows:

Will the waste meet Envelope Limits after staging (including dissolution), blending, and/or shimming?

Will the quantity of retrievable sodium satisfy the quantity requirements?

Does the waste have acceptable transfer properties?

4.0 STEP 3--INPUTS TO THE DECISION

The inputs to this decision on whether Tank T is appropriate for Batch X are divided into several major categories. The inputs for these categories are listed in the following sections.

4.1 DILUTION RATIO AND DILUENT COMPOSITION REQUIREMENTS

The requirements listed below are addressed by performing a process test.

- Minimum dilution ratio that satisfies all transfer system requirements
- Maximum dilution ratio where gibbsite becomes a problem
- Desired dilution ratio.

4.2 TRANSFER REQUIREMENTS

The requirements are listed below.

- Confirm that the as-retrieved waste (including dilution water or caustic) remains below saturation in major Na salts during the transfer to the staging tank (Kirkbride et al. 1997).
- Confirm that the as-retrieved waste (including dilution water or caustic) remain 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 staging tank. These values were used by Galbraith et al. (1996) in analyzing the capability of the proposed transfer routes for staging of feed.
- Confirm that the dilution ratio, diluent composition, and waste composition are balanced so gibbsite or high viscosity slurries do not precipitate.

These inputs (above) should not be confused with input requirements for the design and installation of transfer equipment, which will be covered in the following:

- The transfer equipment portion of the Equipment Design PSDQO (Claghorn 1998)
- Determination that there is no waste compatibility concern with the material being transferred (Waste Compatibility DQO, Mulkey 1997)
- Evaluation of the proposed activities against the authorization basis that begins with the Unreviewed Safety Question (USQ) Process (Safety PSDQO, Papp 1998).

4.3 MIXING REQUIREMENTS

These requirements allow confirmation that (1) the baseline retrieval equipment is consistent with the operating scenario and (2) solids in Tank T behave as expected with respect to dissolution and solid/liquid separation via in-tank settling.

- Confirm that the baseline retrieval equipment that will be used to mobilize and transfer the waste is consistent with the operating scenario.
- Confirm that the portion of the solids thought to be soluble are soluble and that they dissolve in a reasonable[1] amount of time.
- Confirm that the undissolved solids settle and that they settle in a reasonable[1] amount of time.

The inputs here should not be confused with the inputs required for the design and installation of a particular mixer pump to be placed in feed source Tank T for Batch X. Those inputs will be covered in the mixer pump portion of the Equipment Design PSDQO (Claghorn 1998) for Tank T for Batch X.

4.4 ENVELOPE AND QUANTITY REQUIREMENTS

4.4.1 Envelope Requirements

Envelope requirements[2] are taken from Specification 7 in Section C.6 of the contracts (DOE-RL 1996) and Section 3.3.2 of the ICD (PHMC 1997). Envelope limits are intended to apply to the feed that is actually delivered to the privatization contractors (i.e., in the staging tanks 241-AP-102 and -104), which is not always the same as the composition of the waste residing in Tank T, the source tank.

- Concentration limits for the chemical and radionuclide content of the feed.
  Enabling Assumption: These limits apply only to the liquid phase.
- Concentration limit for the sodium concentration of the feed.
  Enabling Assumption: These limits apply only to the liquid phase.

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[1]For the durations to be considered reasonable, they must fit within the allocated time on the PMBS and corresponding logic diagrams.

[2] At this point in feed staging, estimating that the contract envelope requirements will likely be met is sufficient. Blending and shimming options provide the flexibility at later stages, if an analyte approaches or falls outside of the maximum or minimum allowable limit.

- Insoluble solids fraction limit
- Operating Specifications from OSD-T-151-00007 (e.g. relating to corrosion, . . .)
- Maximum ^{137}Cs concentration
- The PHMC assumed minimum limits to distinguish between Envelope A and C and between Envelopes A and B (this requirement is important so a specific batch is associated with an exclusive envelope).

4.4.2 Quantity Requirements

These requirements are taken from Section H.9 of the contracts (DOE-RL 1996), Section 3.3.4 of the ICD (PHMC 1997), or the TWRSO&UP (Kirkbride et al. 1997). Quantity limits are intended to apply to the feed that is actually delivered to the privatization contractors, which is not always the same as the quantity of the waste residing in Tank T.

- Batch size (mass of sodium) constraints (from the contracts)
- PHMC targeted batch size range (from the ICD)
- PHMC desired batch size (from Operating Scenario)

4.5 MISCELLANEOUS INPUT

The following information is needed.

- The physical form of Tank T contents (crust, supernate, settled solids, salt slurry, metal oxide sludge). This is used to confirm that the baseline retrieval equipment is consistent with the operating scenario.
- Estimated composition of heel from the prior batch remaining in staging tanks, if this heel will significantly influence the composition of Batch X (this will be provided from the computer simulation that modeled the operating scenario in the TWRSO&UP).
- Amount of chemicals to be added for shimming Batch X, if any.
- RL direction on the issues identified in the TWRSO&UP and the ICD that potentially affect requirements.

5.0 STEP 4--DEFINE THE STUDY BOUNDARIES

The spatial boundaries are the contents of Tank T.

The temporal boundaries are after Tank T has been selected as a candidate for Batch X and before transfer of Tank T waste to the intermediate waste feed staging tanks (241-AP-102 and -104). The *Data Quality Objectives for TWRS Privatization Phase I: Low-Activity Waste Feed Delivery Transfer to Privatization Contractors* (PSDQO-09) (Certa 1998) will deal with the qualification and delivery of the feed batch.

6.0 STEP 5--DEVELOP A DECISION RULE

The decision rule for confirming that Tank T is appropriate for Batch X is as follows:

> *IF { [Dilution Ratio and Diluent Composition Requirements are Satisfied] AND [Transfer Requirements are Satisfied] AND [Mixing Requirements are Satisfied] AND [Envelope and Quantity Requirements are Satisfied] AND [Miscellaneous Inputs are Satisfied] }THEN Tank T is appropriate for Batch X.*

The elements of the decision rule (the terms in the [Brackets]) will be developed on a case-by-case basis as this PSDQO is applied by the Tank Waste Retrieval Division to each specific Tank T and Batch X combination. This provides the flexibility to account for unique factors that may only become apparent during the application of the PSDQO and to take advantage of existing data whenever possible.

The first step in addressing the elements in the decision rule is for the Tank Waste Retrieval Division to translate its operating scenario into a series of process steps[1] (essentially a process flowsheet) that clearly defines the waste[2] to which each element of the decision rule applies.

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.

The third step is to determine if the needed data to address each element can be supplied by or approximated with existing or new characterization data on the waste, with other waste, statistical evaluations, mathematical or process models, or by process testing on existing or new samples of that or other waste. This determination will be made by the Tank Waste Retrieval Division with input from TWRS Characterization.

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[1]For example only, an operating scenario used to create Batch 1 from 241-AN-105 may be as follows: (a) degas the tank; (b) decant and transfer half of the supernate from 241-AN-105 into 241-AP-102 and the other half into 241-AP-104 using a dilution ratio of x:1 and a diluent of 2 M NaOH; (c) add y ML of dilution water to the salt slurry remaining in 241-AN-105; (d) mix to dissolve soluble salts; (e) allow undissolved solids to settle; (f) decant and transfer half of the clarified liquid in 241-AN-105 into 241-AP-102 and the other half into 241-AP-104; (g) mix the waste in 241-AP-102 and mix the waste in 241-AP-104.

[2]For example only, the decision rule for second transfer (f in footnote 1, above) will need to apply to that portion of the salt slurry that dissolves under the stated dilution conditions.

6.1 ELEMENTS OF DECISION RULES

The application specific decision rule and associated process test protocol[1] (if a process test is needed) will be developed when the PSDQO is applied to a specific waste feed batch.

1. Determine the desired dilution ratio and diluent composition for each waste transfer. The range of dilution ratios and the diluent composition to be evaluated will be estimated from existing composition and thermodynamic equilibrium calculations (test results from similar waste may also be used). For each waste transfer: (a) Determine the minimum dilution ratio which satisfies all transfer system requirements except for gibbsite formation (at tank temperature); (b) Determine the maximum dilution ratio, beyond which gibbsite will form (at tank temperature) or based on allowable tank storage space considerations; (c) Select a desired dilution ratio slightly above the minimum ratio for the desired diluent.

2. For each waste transfer at the desired dilution ratio and diluent composition verify that all of the transfer requirements in Section 4.2 (Transfer Requirements) are satisfied.

3. The need for mixing depends upon the form of Tank T contents and the form that the Tank T contents must be in to make up the Batch X. (a) If a significant quantity of solids require dissolution, then verify that the baseline retrieval equipment includes provisions for mixing the waste. For that fraction of the waste which requires dissolution of solids, (b) Determine if the solids dissolve and if they dissolve in a reasonable[2] amount of time, (c) Determine if the suspended undissolved solids settle and if they settle in a reasonable[2] amount of time.

4. Verify that the requirements in Sections 4.4.1 (Envelope Requirements) and 4.4.2 (Quantity Requirements) are satisfied by the sample of waste that will be representative of the waste staged as feed Batch X.

   One special consideration, is that a portion of this sample should be monitored for a long enough period to verify that gibbsite or high viscosity slurries (such as slurries containing acicular Na_3PO_4 crystals) do not form upon standing. The period should consider the length of time the staged feed may remain in the staging tank prior to delivery to the private contractors feed tank.

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[1]One example of such protocol is given in Garfield (1997).

[2]For the durations to be considered reasonable, they must fit within the allocated time on the PMBS and corresponding logic diagrams.

5. For each miscellaneous input listed in Section 4.5, determine which of these inputs apply to the specific Tank T being considered for Batch X and verify that each applicable input is addressed.

7.0 STEP 6--SPECIFY LIMITS ON DECISION ERROR

This step will be revisited with each application of the PSDQO to a specific Tank T / Batch X pair.

7.1 DILUTION RATIO AND DILUENT COMPOSITION REQUIREMENTS

Prior data show that the desired dilution ratio and diluent composition for problem-free transfers can span a significant dilution ratio and diluent composition range. Hence, measures of the desired dilution ratio and diluent composition do not require precision, as long as these process tests follow standard laboratory practices and the standard quality assurance procedures for such process testing.

7.2 TRANSFER REQUIREMENTS

Decision error is not a concern with the 1.41 SpG requirement at this point, since the staged feed can be easily adjusted in the intermediate feed staging tank if necessary to satisfy the 1.41 SpG limit.

The objective of the other transfer requirements is to provide a qualitative indication that the waste is pumpable. Parameters higher than 80 percent of the maximum allowable value are considered "flagged" for further examination. The Process Control PSDQO (Peters and Certa 1998) and Equipment Design PSDQO (Claghorn 1998) may require quantitative information.

7.3 MIXING REQUIREMENTS

These tests are intended to be a qualitative indication that the waste will dissolve reasonably fast and that any undissolved solids are "settleable." Qualitative here means that dissolving and settling are much faster than the time allotted during processing (e.g., dissolving in minutes versus days allotted). The Process Control PSDQO (Peters and Certa 1998) and Equipment Design PSDQO (Claghorn 1998) may require more quantitative information.

7.4 ENVELOPE AND QUANTITY REQUIREMENTS

The objective is to make sure that the waste composition in Tank T is close enough to the required envelope composition so that the waste will fit the envelope either as-is or with blending and shimming.

Where point estimates of the waste composition are used: analytes that do not satisfy the envelope requirements or approach within 20 percent of an envelope requirement are considered "flagged" for further examination.[1]

Where best-basis inventory data can be used directly or as a bounding case, existing tank characterization data used to establish the best-basis inventory data should be evaluated statistically. Appropriate analysis of variance (ANOVA) models should be used to estimate the 95 percent confidence intervals around the mean for each analyte:sodium ratio. Components which fall outside of the envelope requirements or are missing are considered "flagged" for further examination. (Example of such statistical evaluation is Chapter 7.0 of Welsh [1997].)

For volume percent solids, and volume of feed transferred: Parameters higher than 80 percent of the maximum allowable value are considered "flagged" for further examination. For the amount of Na in a batch: a value of less than 120 percent of minimum values or outside +/- 20 percent of the target or desired values are considered "flagged" for further examination.

For SpG or density: values that are higher than maximum limit or are closer to the maximum limit by 0.05 SpG[2] units or less are considered "flagged" for further examination.

7.5 MISCELLANEOUS REQUIREMENTS

The objective of these requirements is to assure that any additional elements that may affect a determination that Tank T is appropriate for Batch X are considered and resolved. Because of the nature of these requirements, a yes or no determination is usually adequate. If more quantification is required, that quantification will be covered in the application of this PSDQO.

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[1]Both the Waste Disposal Integration Team (WIT) and PHMC have been using the 20 percent value to identify potential problems in either defining or meeting envelope specifications. This estimate allows for typical sampling and analytical error and allows for a reasonable level of blending and/or shimming, if required.

[2]If densities are used instead of SpG, then substitute 0.05 g/ml for 0.05 SpG units.

8.0 STEP 7--OPTIMIZE THE DESIGN FOR OBTAINING DATA

This step will be revisited during the application of the PSDQO to a specific Tank T / Batch X pair. Optimization of the design for obtaining the data, if any, will take place during the preparation of a sampling and analysis plan or process test plan.

Due to the nature of the questions being asked, there is little room for optimization. The costs associated with collecting samples and performing analyses so that the right feed are delivered are small compared to overall feed staging and delivery costs and the potential costs of not delivering the right feed on time. As long as the needed information can be easily obtained, there is no benefit in trying to optimize obtaining that information, especially if optimization would result in developing and pursuing a new protocol. The intent is to make use of standard analytical methods and protocols whenever possible.

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APPLICATION OF

"CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR LOW-ACTIVITY WASTE FEED BATCH X"

TO

241-AN-105 / BATCH 1

January 1998

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CONTENTS

LIST OF TERMS

DOE	U.S. Department of Energy
ICD	Interface Control Document
LAW	Low-Activity Waste
M	Molar (gmoles/liter)
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
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
USQ	Unreviewed Safety Question
WIT	Waste Disposal Integration Team
WTC	Whole tank composite

APPLICATION OF "CONFIRM TANK T IS AN APPROPRIATE FEED SOURCE FOR LOW-ACTIVITY WASTE FEED BATCH X" TO 241-AN-105 / BATCH 1

1.0 INTRODUCTION

This addendum applies Revision 0 of "Confirm Tank T is an Appropriate Feed Source for Low-Activity Waste Feed Batch X" problem-specific data quality objectives (PSDQO) to tank 241-AN-105 / Batch 1.

This application will also serve as a user test for the PSDQO since it is the first time the PSDQO will be applied.

This application of PSDQO-01 is divided into a Base Case Operating Scenario and an Alternative Case Operating Scenario. The Base Case homogenizes the waste in tank 241-AN-105 by mixing prior to transfer to 241-AP-102 and -104. The Alternative Case transfers the tank 241-AN-105 supernate to 241-AP-102 and -104 without mixing followed by subsequent diluent addition and mixing in 241-AN-105 before transfer to 241-AP-102 and -104.

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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 *Tank Waste Remediation System Operation and Utilization Plan* (TWRSO&UP) (Kirkbride et al. 1997) includes the following steps to make up Batch 1:

- Empty, flush, and empty 241-AP-102 and -104 (the feed staging tanks) leaving a dilute, 0.1 ML (10-in.) heel behind in each tank.

- Homogenize the waste in 241-AN-105 using mixer pumps to resuspend the salt slurry.

- Transfer half of the homogenized waste in 241-AN-105 to 241-AP-102 and the remaining half to 241-AP-104, leaving a 0.1 ML (10-in.) heel. During the transfer, the proper amount of diluent will be added to the waste at the transfer pump inlet.

- Mix the waste in 241-AP-102 and mix the waste in 241-AP-104.

- Allow undissolved solids to settle.

The dilute heel in 241-AP-102 and -104 can be neglected for the purposes of this PSDQO; how clean the staging tank needs to be is an operational issue, not a "Confirm Tank T..." issue.

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

Element 1, Dilution Ratio and Diluent Composition: this applies to the whole tank composite (WTC) of 241-AN-105 over the temperature range of 25 to 65 °C.

Element 2, Transfer Requirements: there are two nearly identical transfers; they will be treated as one transfer. Transfer requirements apply to a whole tank composite of the waste currently in 241-AN-105 after addition of the proper amount of diluent over the temperature range of 25 to 65 °C.

Element 3, Mixing Requirements: the mixing requirement applies to a salt slurry composite of the waste currently in 241-AN-105 over the temperature range of 25 to 65 °C.

Element 4, Envelope Requirements: there is one unique Batch 1 composition; the composition and physical properties are that of a whole tank composite of the waste currently in 241-AN-105 after addition of the proper amount of diluent over the temperature range of 25 to 65 °C. The dilute heel in 241-AP-102 and -104 can be neglected for the purposes of this PSDQO (all current data strongly indicate that the 241-AP-102 and -104 heel will not interfere with staging the compositionally correct feed); how clean the tank needs to be is an operational issue, not a "Confirm Tank T..." issue.

Element 5, Miscellaneous Inputs: These inputs apply to the whole tank composition of 241-AN-105 or to changes in the operating scenario that may be imposed in the future.

Evaluate existing data and determine information needs.

Table 1 contains the evaluation of the base case operating scenario for all the elements of the decision rules found in Section 6 of the PSDQO. The table lists each element taken from Section 6.1 of the PSDQO. For each element, the requirements specific to 241-AN-105 / Batch 1 are listed. Each requirement is evaluated against existing data and the remaining information needs are identified. The information needs are summarized in Table 3.

2.2 ALTERNATIVE CASE OPERATING SCENARIO

Translate the operating scenario into a series of process steps.

The TWRSO&UP (Kirkbride et al. 1997) recommended that process control issues be taken into account. This alternative case operating scenario was developed based on consideration of process control issues and is currently being evaluated and incorporated into the project master baseline schedule and corresponding logic diagrams. The steps that directly affect the composition of Batch 1 are listed below:

- Empty, flush, and empty 241-AP-102 and -104 (the feed staging tanks) leaving a dilute, 0.1 ML (10-in.) heel behind in each tank.

- Decant the supernate in 241-AN-105; transfer half of the supernate to 241-AP-102 and the remainder to 241-AP-104, leaving a 10-in. heel above the salt slurry. During these transfers diluent will be added to the waste at the pump inlet.

- Add diluent to the salt slurry in 241-AN-105 and mix.

- Allow undissolved solids to settle in 241-AN-105.

- Transfer half of the liquid in 241-AN-105 to 241-AP-102 and the remaining to 241-AP-104, leaving a 10-in. heel. No additional diluent is expected to be needed for the transfer.

- Mix the waste in 241-AP-102 and mix the waste in 241-AP-104.

- Allow any undissolved solids that were inadvertently entrained to settle in 241-AP-102 and -104.

The dilute heel in 241-AP-102 and -104 can be neglected for the purposes of this PSDQO; how clean the tank needs to be is an operational issue, not a "Confirm Tank T..." issue.

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

Element 1, Dilution Ratio and Diluent Composition: this applies to (a) a supernate composite from 241-AN-105 and (b) a salt slurry composite from 241-AN-105, both over the temperature range of 25 to 65 °C.

Element 2, Transfer Requirements: out of four transfers, there are two distinct transfers. The transfer requirements applies to (a) supernate composite from 241-AN-105 after addition of the proper amount of diluent and (b) a salt slurry composite from 241-AN-104 after addition of the proper amount of diluent and settling of undissolved solids over the temperature range of 25 to 65 °C.

Element 3, Dissolution Requirements: the dissolution requirements applies to the whole tank composite of the waste currently in 241-AN-105 over the temperature range of 25 to 65 °C.

Element 4, Envelope Requirements: there is one unique Batch 1 composition; the composition and physical properties are that of a whole tank composite of the waste currently in 241-AN-105 after addition of the proper amount of diluent over the temperature range of 25 to 65 °C. The dilute heel in 241-AP-102 and -104 can be neglected for the purposes of this PSDQO (all current data strongly indicate that 241-AP-102 and -104 heel will not interfere with staging the compositionally correct feed); how clean the tank needs to be is an operational issue, not a "Confirm Tank T..." issue.

Element 5, Miscellaneous Inputs: these inputs apply to the whole tank composition of 241-AN-105 or to changes in the operating scenario that may be imposed in the future.

Evaluate existing data and determine information needs.

Table 2 contains the evaluation of the alternative case operating scenario for all the elements of the decision rule found in Section 6 of the PSDQO for Confirm Tank T. The table lists each element of the decision rule taken from Section 6.1 of the PSDQO. For each element, the requirements specific to 241-AN-105 / Batch 1 are listed. Each requirement is evaluated against existing data and remaining information needs are identified. The information needs are developed more fully in Table 3.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
Element 1, Dilution Ratio and Diluent Composition	Determine the desired dilution ratio and diluent composition for each waste transfer.	A process test was performed (Herting 1997a). The test was conducted in accordance with a test plan (Herting 1997b). The test plan was based on instruction provided by the Disposal Program (Garfield 1997). The whole tank composite (WTC) results of this test apply to the Base case operating scenario. The test determined that the required dilution ratio[1] is 50-75% and that the desired diluent is water. Dilution ration and Diluent composition established.	No further information is needed.
Element 2, Transfer Requirements	Confirm that the as-retrieved waste (including dilution water or caustic) remains below saturation in major Na salts during the transfer to the staging tank.	Herting (1997a, Section 5.3.3) found that beyond a dilution ration of 50% for the WTC the supernate is below saturation in major Na salts. Below saturation established.	No further information is needed.
	Confirm that the as-retrieved waste (including dilution water or caustic) remain 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 staging tank.	Herting (1997a, Section 3.3.1) found that the viscosity of the WTC at a 50% dilution ratio over the temperature range of 28 to 65 °C varies from 2.5 to 6.0 cP. All samples exhibited Newtonian behavior. Continued dilution to 75% is expected to further reduce the viscosity since no additional solids were observed to precipitate. The largest observed quantity of settled solids that Herting (1997a, Table 4-1) observed for WTC dilutions of 50% and 70% at temperatures of 25, 45 and 65 °C at 20 hours after mixing was 15 volume %. Herting (1997a, Section 3.1) found that the liquid phase density for WTC dilutions of 50% and 75% performed at temperatures of 25, 45 and 65 °C ranged from 1.28 to 1.39 g/ml. Bulk densities calculated from the raw data in this section range from 1.30 to 1.39 g/ml. These values are less than the limit by more than 0.05 g/ml. Correction for reference conditions for SpG are not important. Viscosity, SpG, suspended solids no concern.	No further information is needed.

[1]In this addendum, a dilution ratio is the volume ratio of diluent to undiluted waste expressed as a percentage.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Confirm that the dilution ratio, diluent composition, and waste composition are balanced so gibbsite or high viscosity slurries do not precipitate	Herting (1997a, Section 2.2) did not observe precipitation during extended storage (4-8 weeks) of supernate sub-samples from the WTC dilution tests at 0, 25, 50 and 75% dilution at temperatures of 25, 45 and 65 °C. This covers all practical dilution ratios. Special Consideration: If gibbsite will form, it should form within four weeks. Samples were observed for 4-8 weeks. No precipitation concern.	No further information is needed.
Element 3, Mixing Requirements	Confirm that the portion of the solids thought to be soluble are soluble and that they dissolve in a reasonable amount of time.	The Base case operating scenario (Kirkbride et al. 1997) assumed that the majority of the solids in 241-AN-105 would dissolve. Herting (1997a, Table 4-5) found that the undissolved solids at 50 and 75% dilution for temperatures of 25, 45 and 65 °C varies from 0.2 - 0.4 true wt% (the undiluted samples ranged from 3.8 - 4.8 true wt%). This is consistent with the Base case operating scenario which has 3 wt% solids in the undiluted waste and 0.5 wt% solids after dilution. Herting (1997a, Section 1.1) found that dissolution kinetic were very fast (dissolution was complete after about 15 seconds). Note: Confirmation that a mixer pump can provide the necessary amount of mixing to dissolve the solids in the tank in a reasonable amount of time is within the scope of the Equipment Design PSDQO. Solids solubility no concern.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Confirm that the undissolved solids settle and that they settle in a reasonable amount of time.	Herting (1997a, Section 3.1) found that the undissolved solids will settle and do so in about 20 hrs. Scale-up calculations for Herting's settling data have not been performed. The base case time allocated in the TWRSO&UP (Kirkbride et al. 1997, Assumption 6.11) for settling is taken by reference from (Certa et al. 1996) and is 30 days. Special Consideration: The dissolved air in the dilution water was salted out when mixed with the undiluted waste. The resulting foam kept a portion of the solids from settling. The foam dispersed and solids settled upon mixing again.	Estimated time to settle undissolved solids at full scale. (See Table 3, Item # 1).
	Confirm that the baseline retrieval equipment that will be used to mobilize and transfer the waste is consistent with the operating scenario.	Tank 241-AN-105 contains about 40% by volume of a salt slurry. The best basis inventory also shows that the salt slurry contains approximately 40% of the total sodium (Jo 1997). The base case operating scenario targets most of the sodium in the salt slurry for feed. The equipment required to mobilize and retrieve the slurry includes mixer pumps and a transfer pump with water (and caustic) dilution capability (Boston 1997). This is consistent with the equipment identified in the base case operating scenario (Kirkbride et al. 1997). Retrieval equipment to be added to 241-AN-105 will accomplish requirements.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
Element 4 - Part 1: Envelope Requirements These limits apply to the feed actually delivered to the private contractors.	Concentration limits for the chemical and radionuclide content of the feed (DOE-RL 1996, Section C.6). See Tables 1A and 1B for the limits.	Only Envelope A limits apply to Batch 1. The TWRSO&UP (Kirkbride et al. 1997, Tables I-1 and I-3)) compared the point estimates[1] of the composition of the feed from 241-AN-105 to the Envelope limits and "flagged" TOC as requiring further examination. The TOC was at 82% of the maximum limit of 0.06 gmole TOC/gmole Na; All other analytes were below 80% of their maximum limits. Resolution of "flag": (1) TOC was not identified as a problem by Welsh (1997) or by Herting (1997a); (2) RL is negotiating an increase in the TOC limit from 0.06 gmole TOC/gmole Na to 0.5 gmole TOC/gmole Na. Welsh (1997, Section 7.1 and 7.2) calculated the mean concentration and UL[2] for the bulk tank composition[3] using four variations on segment data and two variations on composite data. The means and UL for all analytes and methods were below the maximum envelope limits, with the following exception: In two variations based on segment data that used fusion digest slurry data the means for Ba.icp and La.icp and the UL for Ba.icp, La.icp, Ni.icp.wo, Pb.icp.w and Pb.icp.wo exceeded their respective envelope limits. These are "flagged" for further consideration.	No further information is needed.

[1]These point estimates were based on the best basis inventory for 241-AN-105. A thermodynamic model (ESP) was used to estimate the liquid phase composition of the diluted waste.

[2]The UL is the upper 95 percent confidence interval for random variability.

[3]For 241-AN-105, the bulk inventory can be used as a bounding case in estimating the analyte:Na ratios. The quantity of each bulk analyte inventory will be equal to or greater than that in the liquid phase of the diluted waste. The bulk quantity of sodium in the tank will be about the same as the sodium in the liquid phase after dilution with water since nearly all of the sodium has been removed from the solids at a 50% or greater dilution. Any bias in the analyte:Na mole ratios estimated directly from the bulk inventory will tend to be high (that is, conservative for comparison to maximum envelope limits).

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Concentration limit for the sodium concentration of the feed: 3 M ≤ [Na] ≤ 14 M (DOE-RL 1996, Section C.6).	Resolution of "flag": (1) The fusion digest results are overly conservative in that they dissolve essentially all solids while the alternative method (acid digest) dissolves all water soluble solids and most other solids. (2) The fusion digest method results in large "less than" values due to the additional dilution of the sample (about an order of magnitude greater than the acid digest). Herting (1997a, Section 1.0) found that "under all dilution conditions studied, the retrievable waste fell within the feed specification limits established for Envelope A in the Phase I Privatization contracts". Compliance with Envelope A achieved. c Herting (1997a, Table 8-1) found that the [Na] is 7.56 M for a 50% dilution ratio and 6.57 M for 75% dilution. The worst case (for the various statistical models and analytical methods employed) estimate of bulk [Na] is a mean of 12.7 M with a 95% CI around the mean of 10.3 M - 15.2 M (Welsh 1997, Section 7). Dilution of waste with a 15.2 M [Na] at a 50% dilution ration will yield a [Na] of 10.1 M. Compliance with Na molarity achieved.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Insoluble solids fraction limit will not exceed 5 volume % (DOE-RL 1996, Section C.6).	The contracts do not define how the volume percent insoluble solids will be measured. Herting (1997a, Table 4-1) measured the quantity of solids and expressed the results several difference ways. The ranges given below are for WTC dilutions of 50% and 70% at temperatures of 25, 45 and 65 °C at 20 hours after mixing: 9-15 volume % settle solids → "Flagged" 3-7 volume % centrifuges solids → "Flagged" 2.6 to 3.6 weight % centrifuged solids (wet) 0.2 to 0.6 weight % true solids. Resolution of "Flag": (1) The PHMC will use the decant system planned for the intermediate feed staging tanks (Britton et al. 1996) for control of solids in the feed delivered to the private contractors, if needed. (2) Issue 19T of ICD 19 (PHMC 1997a) addresses this solids measurement issue. RL is negotiating a change in this limit from volume % to weight percent. Compliance with insoluble fraction will be resolved administratively.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Operating Specifications from OSD-T-151-00007 (DOE-RL 1996, Section C.6 invokes the OSD by reference). See Table 4.	The contract does not explicitly state which specifications from the OSD apply to the waste. The PHMC assumes that the Tank Composition (7.2.1) and Heat Generation Rate (7.2.8) limits apply to the waste. These limits are shown in Table 4. The TWRSO&UP (Kirkbride et al. 1997, Section 3.1.1.6) compared the point estimates of the composition of the waste as staged in 241-AP-102 and -104 with the Tank Composition (Tank Corrosion) specifications. All limits were satisfied for Batch 1. Uncertainty is not an issue since the [OH], [NO_2] and [NO_3] in the staging tanks can be adjusted if needed before the feed qualification samples are taken. The TWRSO&UP (Section 3.1.1.6) also evaluated the heat generation rate rule and found that all limits were satisfied for Batch 1, decayed to the estimated time of delivery. The estimated heat generation rate for Batch 1 is 7,820 BTU/hr for Contractor 1 and 7,870 BTU/hr for Contractor 2. This is well within the maximum limit of 70,000 BTU/hr. The tank characterization report estimated the total heat load in 241-AN-105 (Jo 1997) to be 9,840 W (33,600 BTU/hr total, 16,800 per Batch). This estimate is also well below the maximum limit. This estimate is conservative since it does not take into account the additional decay that will take place before delivery of the feed Batch. Conformance with OSD factors achieved.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Maximum ^{137}Cs concentration of 5.86 E10 Bq/liter (6 Ci/gal).	This limit is equivalent to 1.59E6 μCi/L. The OSD limit of 5.74E5 μCi/L is more restrictive. Using the best basis inventory and reported volume for 241-AN-105 from Jo (1997), the bulk [137Cs] is calculated to be 4.7E5 μCi/L and [90Sr] is 7.9E3 μCi/L. These are both well below the OSD limits of 5.74E5 μCi/L and 4.04E5 μCi/L, respectively. This is a conservative comparison since the 50-70% dilution has not been accounted for in the above estimates. Conformance with maximum ^{137}Cs concentration achieved.	No further information is needed.
	The PHMC assumed minimum limits to distinguish between Envelope A and C and between Envelopes A and B	These discriminators do not apply to Batch 1 (Envelope A). No concern about distinguishing between envelopes.	No further information is needed.
Element 4 - Part 2: Quantity Requirements	Batch size (mass of sodium) constraints (from the contracts) ≥ 500 MT Na.	Herting (1997, Table 7-2a) found that 946 MT Na are recoverable at 50% dilution ratio and 1016 MT Na are recoverable at 75% dilution ratio (the difference is mainly due to leaving less sodium behind in the interstitial liquid associated with the settled solids - the sodium concentration is less for the greater dilution). The recoverable sodium is less than 120% of the minimum limit and is "flagged" for further evaluation. Resolution of "flag": (1) if necessary, the PHMC will blend in additional waste or shim the feed batch to meet the 500 MT Na requirement; (2) The minimum 500 MT size for the first batch is not driven by technical or cost considerations; (3) The PHMC has already identified this as an issue (PHMC 1997, Issue 19H) and (Kirkbride et al. 1997, Section 3.1.3). RL is considering the recommendation to reduce this limit to 300 MT Na. (4) The availability of the engineering solution in number (1) avoids the need for additional tank characterization data. Na quantity requirements will be resolved administratively or by engineering solution.	No further information is needed.

Table 1. Base Case Operating Scenario Evaluation. (9 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	PHMC targeted batch size range (from the ICD (PHMC 1997, Table 3D): 500 - 600 MT Na.	Same as above. Na quantity requirements will be resolved administratively or by engineering solution.	No further information is needed.
	PHMC desired batch size (from Operating Scenario): 514 MT Na (Kirkbride et al. 1997, Table 3.1-5)	Same as above. Na quantity requirements will be resolved administratively or by engineering solution.	No further information is needed.
Element 5 - Miscellaneous Inputs	Physical form of Tank 241-AN-105 contents	From Jo (1997): 241-AN-105 has a noncontinuous floating crust layer that may be up to 30 cm (1-ft) thick. The layer is easily penetrated and is composed of easily dissolvable salts. There is approximately 6.4 m (21 ft) of supernate which is compositionally homogenous. There are approximately 4 m (13 ft) of settled solids. There is no hard pan.	No further information is needed
	Heel from prior batch remaining in staging tanks	This is the first batch. Heels remaining from cleanout of 241-AP-102 and -104 are addressed in Section 2.1 above.	No further information is needed
	Shimming Batch 1	No shimming is anticipated.	No further information is needed
	RL direction	No changes to applicable M&I ICD requirements have been made to date.	No further information is needed

a. Elements are taken from the Decision Rule statement in Section 6.1 of PSDQO-01.
b. Requirements are taken from Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of PSDQO-01.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
Element 1, Dilution Ratio and Diluent Composition	Determine the desired dilution ratio and diluent composition for each waste transfer.	(a) As applied to supernate composite: This information was not obtained and is still needed.	Desired dilution ratio and diluent composition for a representative sample of supernate (See Table 3, Item # 2)
		(b) As applied to salt slurry composite: A process test was performed (Herting 1997a). The test was conducted in accordance with a test plan (Herting 1997b). The test plan was based on instruction provided by the Disposal Program (Garfield 1997). The settled solids composite results of this test determined that the required dilution ratio[1] is 80-120% and that the desired diluent is water. Dilution and Diluent Composition established.	No further information is needed.
Element 2, Transfer Requirements are Satisfied	Confirm that the as-retrieved waste (including dilution water or caustic) remains below saturation in major Na salts during the transfer to the staging tank.	(a) As applied to supernate composite with proper amount of diluent added: This information was not obtained and is still needed.	See requirement (See Table 3, Item # 3).
		(b) As applied to salt slurry composite with proper amount of diluent added: Analysis of data in Herting (1997a, Section 5.3) found that beyond a dilution ration of 80% for the settled solids the supernate is below saturation in major Na salts. Below saturation established.	No further information is needed.

[1]In this addendum, a dilution ratio is the volume ratio of diluent to undiluted waste expressed as a percentage.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Confirm that the as-retrieved waste (including dilution water or caustic) remain 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 staging tank.	(a) As applied to supernate composite with proper amount of diluent added: This information was not obtained and is still needed.	See requirement (See Table 3, Item # 4).
		(b) As applied to salt slurry composite with proper amount of diluent added: Herting (1997a, Section 3.3.1) found that the viscosity of the settled solids at a 80% dilution ratio over the temperature range of 28 to 65 °C varies from 2.5 to 7.0 cP. All samples exhibited Newtonian behavior. Continued dilution to 120% is expected to further reduce the viscosity since no additional solids were observed to precipitate. The observed quantity of settled solids that Herting (1997a, Table 4-6) observed for the settled solids dilutions of 80% at temperatures of 25, 45 and 65 °C at 20 hours after mixing ranged from 16 - 27 volume %; at 120% dilution they ranged from 12 - 18 volume %. Herting (1997a, Section 3.1) found that the liquid phase density for salt slurry dilutions of 80% and 120% performed at temperatures of 25, 45 and 65 °C ranged from 1.24 to 1.49 g/ml. Bulk densities calculated from the raw data in this section range from 1.24 to 1.38 g/ml. These values are less than the limit by more than 0.05 g/ml. Correction for reference conditions for SpG are not important. Viscosity, SpG, suspended solids no concern.	No further information is needed.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Confirm that the dilution ratio, diluent composition, and waste composition are balanced so gibbsite or high viscosity slurries do not precipitate.	Herting (1997a, Section 2.2) did not observe precipitation during extended storage (4-8 weeks) of supernate sub-samples from the WTC dilution tests at 0, 25, 50 and 75% dilution at temperatures of 25, 45 and 65 °C. This covers all practical dilution ratios. Special Consideration: If gibbsite will form, it should form within four weeks. Samples were observed for 4-8 weeks. No precipitation concern.	No further information is needed.
Element 3, Dissolution Requirements	Confirm that the portion of the solids thought to be soluble are soluble and that they dissolve in a reasonable amount of time.	The Base case operating scenario (Kirkbride et al. 1997) assumed that the majority of the solids in 241-AN-105 would dissolve. Herting (1997a, Table 4-7) found that the undissolved solids at 80 and 120% dilution for temperatures of 25, 45 and 65 °C varies from 4 - 9 volume % centrifuged solids (the undiluted samples ranged from 32 - 40 volume % centrifuged solid). Herting (1997a, Table 4-8) also found that the undissolved solids at 80 and 120% dilution for temperatures of 25, 45 and 65 °C varies from 3.3 - 6.2 wt % centrifuged solids (the undiluted samples ranged from 38.3 - 43.4 wt % centrifuged solid). Most of the solids thought to be soluble are soluble. Herting (1997a, Section 1.1) found that dissolution kinetic were very fast (dissolution was complete after about 15 seconds). Note: Confirmation that a mixer pump can provide the necessary amount of mixing to dissolve the solids in the tank in a reasonable amount of time is within the scope of the Equipment Design PSDQO. Solids solubility no concern.	No further information is needed.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Confirm that the undissolved solids settle and that they settle in a reasonable amount of time.	Herting (1997a, Section 3.1) found that the undissolved solids will settle and do so in about 20 hrs. Scale-up calculations for Herting's settling data have not been performed. Special Consideration: The dissolved air in the dilution water was salted out when mixed with the undiluted waste. The resulting foam kept a portion of the solids from settling. The foam dispersed and solids settled upon mixing again.	Estimated time to settle undissolved solids at full scale (See Table 3, Item # 5)
	Confirm that the baseline retrieval equipment that will be used to mobilize and transfer the waste is consistent with the operating scenario.	The alternative case uses the same retrieval equipment as the base case. See base case evaluation for details. Retrieval equipment to be added to AN-105 will accomplish requirements.	No further information is needed.
Element 4 - Part 1: Envelope Requirements These limits apply to the feed actually delivered to the private contractors.	Concentration limits for the chemical and radionuclide content of the feed (DOE-RL 1996, Section C.6). See Tables 1A and 1B for the limits.	Only Envelope A limits apply to Batch 1. In the alternative case, the composition of the waste staged in 241-AP-102 and -104 is almost identical to that of the base case. There will be differences in absolute concentration due to differences in the total amount of dilution, but this will not affect the [analyte]:[Na] values. There will also be differences due to slightly different extent of solids dissolution, but these are bounded by the evaluation for the Base Case that was based on the Welsh (1997) report. Herting (1997a, Section 1.0) found that "under all dilution conditions studied, the retrievable waste fell within the feed specification limits established for Envelope A in the Phase I Privatization contracts". Compliance with Envelope A achieved.	No further information is needed.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Concentration limit for the sodium concentration of the feed: 3 M ≤ [Na] ≤ 14 M (DOE-RL 1996, Section C.6).	Since the supernate dilution ratio was not established, the resulting [Na] in the Batch can not be directly determined. However, a bounding calculation shows that the lower limit will be satisfied: Assume that the dilution ratio required by the supernate layer will be equal to the dilution ratio required by the salt slurry layer. The lowest (95% CI around the mean for the various statistical models and analytical methods employed) estimate of the bulk [Na] was 10.2 M (Welsh 1997, Section 7). The lowest [Na] in the feed batch is the [Na]bulk/(1+120%/100%) to account for 120% dilution). This yields a value of 4.6 M. Another bounding calculation shows that the upper limit will be satisfied: Assume that no dilution is required by the supernate layer. The overall dilution ratio will not exceed 100%{1-[(.6) + (.4)*(1+80%/100%)]}=32%; The largest (95% CI around the mean for the various statistical models and analytical methods employed) estimate of the bulk [Na] was 15.2 M (Welsh 1997, Section 7). Dilution of waste with a 15.2 M [Na] at a 32% dilution ratio yields a [Na] of 11.5 which is well within the upper limit. In any case, the sodium concentration for the feed batch can be adjusted in the intermediate feed staging tanks. Compliance with Na molarity achieved.	No further information is needed.
	Insoluble solids fraction limit will not exceed 5 volume % (DOE-RL 1996, Section C.6).	In the alternative case, the only solids that should end up in the feed batch are those solids that are inadvertently entrained during the decant transfers. This is an operational issue, not a "Confirm Tank T..." issue. Compliance with insoluble fraction will be resolved by case during operations.	No further information is needed.
	Operating Specifications from OSD-T-151-00007 (DOE-RL 1996, Section C.6 invokes the OSD by reference). See Table 4.	Mass balances have not been performed on the alternative case operating scenario to estimate the composition of the staged feed batch (these can be done explicitly after the supernate dilution ratio has been determined. Bounding calculations can be performed, however it is simpler to wait for the dilution ratio.	Estimated composition of the staged feed (See Table 3, Item # 6).

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	Maximum ^{137}Cs concentration of 5.86 E10 Bq/liter (6 Ci/gal).	This limit is equivalent to 1.59E6 μCi/L. Using the best basis inventory and reported volume for 241-AN-105 from Jo (1997), the bulk [137Cs] is calculated to be 4.7E5 μCi/L. This is well below the maximum limit of 1.59E6 μCi/L. This is a conservative comparison since dilution has not been included. Conformance with maximum Cs achieved.	No further information is needed.
	The PHMC assumed minimum limits to distinguish between Envelope A and C and between Envelopes A and B	These discriminators do not apply to Batch 1 (Envelope A). No concern about distinguishing between envelopes.	No further information is needed.
Element 4 - Part 2: Quantity Requirements are Satisfied	Batch size (mass of sodium) constraints (from the contracts) ≥ 500 MT Na.	Herting (1997, Table 7-2b) found that 973 MT Na are recoverable at 80% dilution ratio and 1011 MT Na are recoverable at 120% dilution ratio (the difference is mainly due the leaving less sodium behind in the interstitial liquid associated with the settled solids - the sodium concentration is less for the greater dilution). The recoverable sodium is less than 120% of the minimum limit and is "flagged" for further evaluation. Resolution of "flag": (1) if necessary, the PHMC will blend in additional waste or shim the feed batch to meet the 500 MT Na requirement; (2) The minimum 500 MT size for the first batch is not driven by technical or cost considerations; (3) The PHMC has already identified this as an issue (PHMC 1997, Issue 19H) and (Kirkbride et al. 1997, Section 3.1.3). RL is considering the recommendation to reduce this limit to 300 MT Na. (4) The availability of the engineering solution in number (1) avoids the need for additional tank characterization data. Na quantity requirements will be resolved administratively or by shimming.	No further information is needed.

Table 2. Alternative Case Operating Scenario Evaluation. (7 Sheets)

Elements[a]	Requirements[b]	Discussion/evaluation	Information needs
	PHMC targeted batch size range (from the ICD (PHMC 1997, Table 3D): 500 - 600 MT Na.	Same as above. Na quantity requirements will be resolved administratively or by shimming.	No further information is needed.
	PHMC desired batch size (from Operating Scenario): 514 MT Na (Kirkbride et al. 1997, Table 3.1-5)	Same as above. Na quantity requirements will be resolved administratively or by shimming.	No further information is needed.
Element 5 - Miscellaneous Inputs	Physical form of Tank 241-AN-105 contents	241-AN-105 has a 30-cm (1-ft) crust that is easily penetrated and is composed of easily dissolvable salts. There is Q ft of supernate which is compositionally homogenous. There are V ft of settled solids. There is no hard pan.	No further information is needed
	Heel from prior batch remaining in staging tanks	This is the first batch. Heels remaining from cleanout of 241-AP-102 and -104 are addressed in Section 2.1 above.	No further information is needed
	Shimming Batch 1	No shimming is anticipated.	No further information is needed
	RL direction	No changes to applicable M&I ICD requirements have been made to date.	No further information is needed

[a]Elements are taken from the Decision Rule statement in Section 6.1 of PSDQO-01.
[b]Requirements are taken from Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of PSDQO-01.

Table 3 was developed jointly by TWRS Characterization and Tank Waste Retrieval. It is intended to show what information is still needed, what can be obtained by calculations with existing data, what requires new (or existing) samples, analysis and/or process testing. Where samples are required, the amount and "representativeness" of the sample will be stated. Where analysis is needed, the specific analytes and QA requirements will be stated. If process testing is needed, the amount of sample and goals of the process test will be stated. Appropriate level of end description of QA requirements will be covered in the specific work plan for these limited process tests.

Table 3. Information Needs.

Item	Information need	Planned resolution	Sample required
1	Estimate time to settle undissolved solids at full scale	Engineering calculations: no additional tests required	None
2	Desired dilution ratio and diluent composition for a representative sample of supernate.	Calculate from results of Item #3 and ESP. No additional tests required.	None
3	Confirm as-retrieved waste remains below satn in major NA salts during transfer.	Perform lab test: measure %solids vs. temp for supernate at 25 and 65 degrees C under 4 conditions: (1&2) increasing temp. undiluted and diluted 15%, (3&4) decreasing temp. undiluted and diluted 15%.	10 g[1] solids and 60 mL supernate
4	Confirm as-retrieved waste remains <10 cP, <1.5 SpG, and <30% solids during transfer.	SpG and %Solids already known. Measure viscosity of undiluted supernate at 25 to 65 C, which should be <10 cP. All dilutions will be lower.	5 g[1] solids and 20 mL supernate
5	See item #1.	See item #1.	None
6	Estimate composition of staged feed.	Can be calculated from existing data after item #2 is resolved.	None

[1]The solids are needed to re-establish the original solid-liquid equilibria that was present in 241-AN-105.

There are six items that have been flagged in Tables 1 and 2 requiring further information. All involve performing a specific process test with specific material from 241-AN-105. There are no other information needs requiring either an analysis of an existing 241-AN-105 sample or the collection of additional sample followed by analysis in order to confirm that tank 241-AN-105 is appropriate for Batch 1.

Table 4A. Low-Activity Waste Feed Liquid Phase Chemical Composition.

Chemical	Maximum ratio, analyte (mole) to sodium (mole)		
Analyte	Envelope A[1]	Envelope B	Envelope C
Al	1.9E-01	1.9E-01	1.9E-01
Ba	1.0E-04	1.0E-04	1.0E-04
Ca	4.0E-02	4.0E-02	4.0E-02
Cd	4.0E-03	4.0E-03	4.0E-03
Cl	3.7E-02	8.9E-02	3.7E-02
Cr	6.9E-03	2.0E-02	6.9E-03
F	9.1E-02	2.0E-01	9.1E-02
Fe	1.0E-02	1.0E-02	1.0E-02
Hg	1.4E-05	1.4E-05	1.4E-05
K	1.8E-01	1.8E-01	1.8E-01
La	8.3E-05	8.3E-05	8.3E-05
Ni	3.0E-03	3.0E-03	3.0E-03
NO_2	3.8E-01	3.8E-01	3.8E-01
NO_3	8.0E-01	8.0E-01	8.0E-01
OH	7.0E-01	7.0E-01	7.0E-01
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4	3.8E-02	1.3E-01	3.8E-02
SO_4	9.7E-03	7.0E-02	2.0E-02
TIC	3.0E-01	3.0E-01	3.0E-01
TOC[2]	6.0E-02	6.0E-02	5.0E-01
U	1.2E-03	1.2E-03	1.2E-03

[1]Only Envelope A applies.
[2]For each atom of Carbon in TOC.

Table 4B. Low-Activity Waste Feed Liquid Phase Radionuclide Content.

	Maximum ratio, radionuclide (Bq) to sodium (mole)		
Radionuclide[1]	Envelope A[3]	Envelope B	Envelope C
TRU[2]	4.8E+05	4.8E+05	3.0E+06
^{137}Cs	4.3E+09	6.0E+10	4.3E+09
^{90}Sr	4.4E+07	4.4E+07	8.0E+08
^{99}Tc	7.1E+06	7.1E+06	7.1E+06

[1]Some radionuclides, such as ^{90}Sr and ^{137}Cs, have daughters with relatively short half-lives. These daughters have not been listed in this table. However, they are present in concentrations associated with the normal decay chains of the radionuclides.

[2]Radionuclides contributing to TRU are those alpha-emitting transuranic radionuclides with half-lives greater than 5 years (^{236}Np, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{242m}Am, ^{243}Am, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, and ^{247}Cm). ^{238}Pu, ^{239}Pu, ^{240}Pu and ^{241}Am are expected to comprise >95 percent of the total measured activity. ^{242m}Am and ^{244}Cm are expected to contribute less than 2 percent of the total measured alpha activity. ^{236}Np, ^{245}Cm, ^{246}Cm, and ^{247}Cm are not expected to be present in Hanford nuclear waste in measurable quantities. Measurement of total alpha activity may provide an adequate screening for comparison with the TRU envelope limit.

[3]Only Envelope A applies.

Table 5. Applicable Waste Composition Limits from OSD-T-151-00007.

7.2.1 TANK COMPOSITION

7.2.1.A Temperatures ($T \leq 212°F$)

Variable	Specification Limit
For $[NO_3^-] \leq 1.0M$:	
$[OH^-]$	$0.010M \leq [OH^-] \leq 5.0M$
$[NO_2^-]$	$0.011M \leq [NO_2^-] \leq 5.5M$
$[NO_3^-]/([OH^-] + [NO_2^-])$	<2.5
(for solutions below 167°F, the $[OH^-]$ limit is 8.0M)	
For $1.0M < [NO_3^-] \leq 3.0M$:	
$[OH^-]$	$0.1\ ([NO_3^-]) \leq [OH^-] < 10M$
$[OH^-] + [NO_2^-]$	$\geq 0.4\ ([NO_3^-])$
For $[NO_3^-] > 3.0M$:	
$[OH^-]$	$0.3M \leq [OH^-] < 10M$
$[OH^-] + [NO_2^-]$	$\geq 1.2M$
$[NO_3^-]$	$\leq 5.5M$

7.2.8 HEAT GENERATION RATE

	Variable	Specification Limit*
1)	Maximum Heat Generation Rate	70,000 BTU/hr, for 241-AN, AP and AW. 50,000 BTU/hr, for 241-SY.
2)	Max. Concentration Cesium-137 (Cs-137)	5.74×10^5 µCi/L for 241-AN, AP, and AW. 4.10×10^5 µCi/L for 241-SY.
3)	Max. Concentration Strontium-90 (Sr-90)	4.04×10^5 µCi/L for 241-AN, AP, and AW. 2.88×10^5 µCi/L for 241-SY

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