ENGINEERING CHANGE NOTICE

1. ECN 653562

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Dave L. Banning, Technical Basis and Planning, R2-12, 372-2728	[] Yes [X] No	04/27/99
	6. Project Title/No./Work Order No. Data Quality Objectives for TWRS Privatization Phase I	7. Bldg./Sys./Fac. No. N/A	8. Approval Designator Q
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-1802, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

Complete revision.

13b. Design Baseline Document? [] Yes [X] No

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

This ECN was generated due to changes which have been made in the privatization contract.

15. Distribution (include name, MSIN, and no. of copies)

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1. ECN (use no. from pg. 1) ECN-653562

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

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

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

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

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. D.L. Banning	K L Banning	4/27/99	PE		
Cog. Mgr. J.W. Hunt	[illegible]	4/27/99	QA		
QA D.C. Board	Don Board	4-27-99	Safety		
Safety			Design		
Environ.			Environ.		
Other J.H. Baldwin	John Baldwin	4/28/99	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Data Quality Objectives for TWRS Privatization Phase 1: Tank Waste Transfer Control

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Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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DATA QUALITY OBJECTIVES FOR TWRS PRIVATIZATION PHASE 1: TANK WASTE TRANSFER CONTROL

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Lockheed Martin Hanford Corporation

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LIST OF TERMS

Bq	Becquerel
Bq/ml	Becquerel per milliliter
Ci/L	curies per liter
CI	confidence interval
df	degrees of freedom
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	Data Quality Objective
DST	Double-Shell Tank
FPMT	Feed Process Management Team
g/L	gram per liter
HLW	high-level waste
LAW	low activity waste
LMHC	Lockheed Martin Hanford Corporation
M	molar
ml	milliliter
MRQ	minimum reportable quantities
QC	quality control
RSD	relative standard deviation
TIC	total inorganic carbon
TOC	total organic carbon
TRU	Transuranic radionuclides
TWRS	Tank Waste Remediation System
UL	upper limit
WIC	Waste Inventory Control
μCi/L	microcurie per liter
μCi/ml	microcurie per milliliter
μg/ml	micrograms per milliliter
%	percent

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1.0 INTRODUCTION

The Phase 1 privatization contract (DOE-RL 1996) requires that the Project Hanford Management Contractors, on behalf of the U.S. Department of Energy, Richland Operations Office, deliver waste feed in appropriate quantities and composition on schedule.

The Feed Process Management Team (FPMT) was created with responsibility for establishing requirements, identifying and recommending baseline change control, assuring configuration management of tank contents (e.g., feed pedigrees), and requiring understanding among the various TWRS elements so the right feed is produced on schedule (Boston 1996).

The FPMT has charged the Double Shell Tank (DST) Waste Inventory Control (WIC) (LMHC 1997) group to develop and implement the waste configuration control needed to insure that our ability to deliver feed on schedule is not adversely impacted. The WIC group, which has representatives from engineering, environmental, operations, and waste feed delivery, reviews proposed waste transfers and technical issues affecting the TWRS waste inventory. The WIC group either approves proposed transfers or, if a unanimous decision is not obtained, elevates approval to the FPMT. A representative from the FPMT is present at the WIC group meetings where waste transfer approvals are decided, and WIC relays information to the FPMT as needed. The TWRS operations include waste inventory control, waste consolidation, waste transfers, compatibility evaluations, feed staging for privatization, and technical issues affecting waste transfers. Pumping restrictions are outlined in Boston (1998).

The mobilization, retrieval, transfer, pretreatment, staging, and delivery of feed to the privatization contractor take place in the DST system. These tanks support multiple programs; therefore, the tank space must be allocated and controlled so as not to interfere with the delivery of feed by creating space bottlenecks or by significantly changing the composition or quantity of feed. Each feed tank selected for Phase 1 processing has been identified as a source of waste for a particular feed envelope. These feed envelope descriptions are identified in the Phase 1 privatization contract.

2.0 STATEMENT OF THE PROBLEM

Specific tanks have been selected to provide waste feed to the private contractor for treatment. Any waste transfer into or out of these specific tanks has the potential of changing the waste so it would no longer meet the required specifications. Therefore, any waste transfer into or out of these tanks must be controlled so the transfer does not compromise the feed envelope selected for that particular tank.

The problem is to determine if a proposed transfer to or from a Phase 1 tank has an adverse impact on the ability to deliver feed of the proper quantities and composition on schedule from that tank during Phase 1 Privatization.

The Phase 1 feed source tanks (Tables 2-1 and 2-2) are nearly full, and there are no currently scheduled plans for moving the waste into or out of these tanks. Many of these tanks also have pumping restrictions (Boston 1998) established by Lockheed Martin Hanford Corporation (LMHC) which limit waste transfers into or out of the tanks. The present restrictions for the addition or removal of the waste in the Phase 1 tanks are shown in Table 2-1 for low activity waste and Table 2-2 for high level waste. However, if a situation occurs where a transfer into or out of these tanks is being considered, this Data Quality Objective (DQO) would apply. This DQO does not apply to tanks before the "static date" (see Tables 2-1 and 2-2) or when waste is being retrieved for transfer to the staging tanks. The "static date" indicates when the tank is expected to contain the desired waste feed material.

Tanks 241-AZ-101 and 241-AZ-102 are found in Table 2-1 and 2-2 because the supernate in these tanks is considered low activity waste while the sludge is considered high level waste.

Table 2-1. Phase 1 Privatization Campaigns Low Activity Waste (2 Sheets)

Feed Envelope	Source Tank	Restrictions	Static Date
A	AN-105	No waste added/removed Watch list tank	11/12/98
	AN-104	No waste added/removed Watch list tank	11/12/98
	AW-101	No waste added/removed Watch list tank	11/12/98
	AN-103	No waste added/removed Watch list tank	11/12/98
B	AP-108	None at this time	2007
	AZ-101	No waste added/removed	11/12/98
	AZ-102		11/12/98

Table 2-1. Phase 1 Privatization Campaigns Low Activity Waste (2 Sheets)

Feed Envelope	Source Tank	Restrictions	Static Date
C	AN-107	No waste added/removed Caustic addition permitted	11/12/98
	AN-102	No waste added/removed Caustic addition permitted	11/12/98
	SY-101	No waste added/removed Watch list tank	11/12/98

Table 2-2. Phase 1 Privatization Campaigns High Level Waste

Feed Envelope	Source Tank	Restrictions	Static Date
D	AZ-101	No waste added/removed	11/12/98
	AZ-102	No waste added/removed	11/12/98
	AY-102	No sludge removed Only C-106 sludge may be added No present restrictions on supernate	11/12/98
	C-106	Single-shell tank No waste added	
	C-102	Single-shell tank No waste added	11/12/98
	C-104	Single-shell tank No waste added	11/12/98

3.0 IDENTIFY THE DECISION

Decisions must be made on three questions to address the problem outlined in Section 2.0. The three decision questions are:

1. Does the waste being transferred to a Phase 1 static tank meet the action level requirements for the waste in that particular Phase 1 tank?

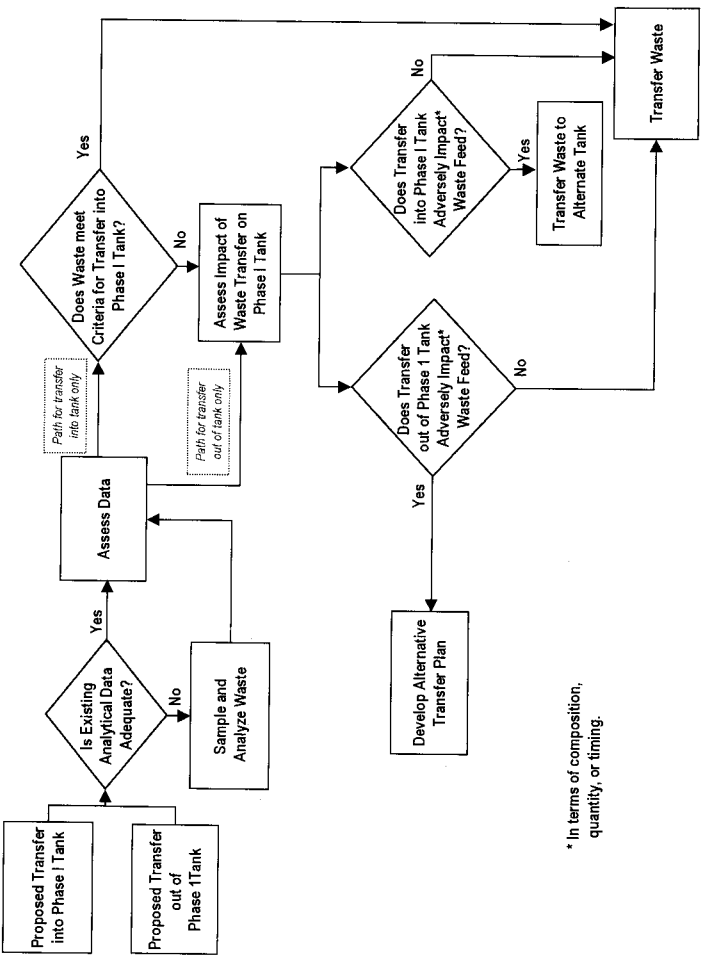
2. If the waste transfer into a Phase 1 tank does not meet the waste feed specifications for that Phase 1 tank, does the waste transfer impact the ability to deliver waste (of the proper quantities and composition on schedule) during Phase 1 Privatization?

3. Does a waste transfer out of a Phase 1 tank impact the ability to deliver waste (of the proper quantities and composition on schedule) during Phase 1 Privatization?

The decision logic for accepting or rejecting a proposed waste transfer into or out of the tanks covered by this DQO (see Tables 2-1 and 2-2) is shown in Figure 3-1.

Depending on the quantity, waste may be transferred into a Phase 1 tank even if it does not meet waste feed specifications. This may be permitted if the quantity of waste is sufficiently small that the composition of the resulting feed batch remains within specifications. The decision to transfer waste into a Phase 1 tank, when the incoming waste does not meet waste feed specifications, is made by the WIC group. The WIC group also makes the ultimate decision on all transfers out of a Phase 1 tank. In addition, the WIC group makes the decision to transfer waste for Envelopes B and C waste in all instances where the discriminating analytes (see the first decision rule, Section 6.0) are not the same.

Figure 3-1. Decision Logic For Waste Transfers



4.0 INPUTS TO THE DECISION

The existing waste transfer compatibility program (Fowler 1995) formalizes the process for determining waste compatibility in terms of both safety and waste management considerations. A transfer assessment is performed on each proposed waste transfer prior to performing the transfer. The detailed rules used in the transfer assessment are documented in *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Mulkey and Miller 1997). The Compatibility DQO was prepared to address safe storage and management of waste. Waste acceptance into the DST system is controlled by the approval of incoming waste streams as documented in waste stream profile sheets, DST system plant operating procedures, and the Compatibility DQO. Any transfers to the tanks covered in this DQO (Phase 1 tanks shown in Tables 2-1 and 2-2) would be required to meet the sampling and analysis requirements discussed in this DQO, as well as existing waste transfer requirements.

Table 4-1 shows the data input required to make a decision on the transfer of waste into a Phase 1 tank. These data will allow a decision to be made on questions 1 and 2 in Section 3.0.

Table 4-1. Information Needed for Waste Transfers into a Phase 1 Static Tank

Input	Reason for Inclusion	Is Information Currently Available?
Na (for tank waste and incoming waste)	Required to determine envelope specifications for waste feed and the quantity of feed.	Available for Phase 1 tank contents. Needed for incoming waste.
Envelope analytes (see Tables 4-3, 4-4, 4-5, 4-6, and 4-7)	Required to determine envelope specifications for waste feed and which envelope the waste matches.	Available for Phase 1 tank contents. Needed for incoming waste.
Solids content	Required to meet waste feed specifications.	Needed for incoming waste only.
OSD-T-151-00007, Rev. H-21 specifications (PHMC 1998) (see Table 4.8)	Required to meet waste feed heat generation and corrosion specification.	Needed for incoming waste only.
Volume of waste (in the tank and to be transferred)	Required to determine impact on waste in the tank if the incoming waste does not meet feed specifications.	Available for Phase 1 tank contents. Needed for incoming waste.

Table 4-2 shows the data input required to make a decision on the transfer of waste out of a Phase 1 tank. These data will allow a decision to be made on question 3 in Section 3.0.

Table 4-2. Information Needed for Waste Transfer Out of a Phase 1 Tank

Input	Reason for Inclusion	Is Information Currently Available?
Na (for tank waste)	Required to determine envelope specifications for waste feed.	Available for Phase 1 tank contents.
Envelope analytes (see Tables 4-3, 4-4, 4-5, 4-6, and 4-7)	Required to determine envelope specifications for waste feed and which envelope the waste matches.	Available for Phase 1 tank contents.
Dissolution/Dilution testing (dissolving solids and analyzing the results for Na and envelope limit analytes)	Required to determine if remaining waste (solids) would meet envelope limits after removal of supernate.	Available for tank 241-AN-105 only. Determination for other tanks is underway (not required for tanks AN-102, AN-106, AN-107, AP-101, AW-104, AZ-101, and AZ-102).
Quantity of waste to be transferred	Required to determine if enough waste remains to meet feed quantity requirements.	No transfers planned at this time.

For waste transferred into a Phase 1 tank, the main data requirement is to meet the waste feed envelopes. There are four (A, B, C, and D) feed envelopes (DOE-RL 1996), which have been applied to the feed batches and tanks (see Tables 2-1 and 2-2). Feed envelope requirements for Envelopes A, B, and C (low activity waste [LAW]) are shown in Table 4-3 for the chemical constituents and Table 4-4 for the radionuclide constituents. Feed envelope requirements for Envelope D (high level waste [HLW]) are shown in Tables 4-5 (non-volatile elements), 4-6 (volatile elements), and 4-7 (radionuclides). In addition to the envelope limits, ^{137}Cs cannot exceed 6 Ci/L for LAW.

In addition to the waste feed envelope requirements, the LAW (Table 2-1) feed must meet the operating specifications found in OSD-T-151-00007, Rev. H-21 (PHMC 1998) (Table 4-8). Also, the sodium requirement for the LAW feed is: $3M \leq [Na] \leq 10M$ and the insoluble solids fraction will not exceed 2% (dry weight) of the waste transferred.

Table 4-3. Low-Activity Waste Feed Chemical Composition Limits (Envelopes A, B, and C).

Chemical Analyte	Maximum ratio, analyte (mole) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
Al	2.5E-01	2.5E-01	2.5E-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
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4^{-2}	3.8E-02	1.3E-01	3.8E-02
SO_4^{-2}	1.0E-02	7.0E-02	2.0E-02
TIC	3.0E-01	3.0E-01	3.0E-01
TOC[1]	5.0E-02	5.0E-02	5.0E-01
U	1.2E-03	1.2E-03	1.2E-03

[1]For each atom of carbon in TOC.
TIC = Total inorganic carbon
TOC = Total organic carbon

Table 4-4. Low-Activity Waste Feed Radionuclide Composition Limits (Envelopes A, B, and C).

Radionuclide	Maximum ratio, radionuclide (Bq) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
TRU[1]	4.8E+05	4.8E+05	3.0E+06
^{137}Cs	4.3E+09	2.0E+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
^{60}Co	6.1E+04	6.1E+04	3.7E+05
^{154}Eu plus ^{155}Eu	1.2E+06	1.2E+06	4.3E+06

[1]TRU is defined as 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).

Total Alpha will be used as a conservative (biased high) indication of the TRU content. The individual radionuclides that contribute to the TRU content will be measured only when the Total Alpha exceeds the TRU envelope limits.

Waste Feed Delivery will not plan to deliver Envelope A feed as Envelope B or C. Therefore, at least one of the Envelope A maximum limits for Cl^-, Cr, F^-, PO_4^{-2}, or SO_4^{-2} must be exceeded for waste to be delivered as Envelope B feed. In addition, at least one of the Envelope A maximum limits for ^{90}Sr or TRU must be exceeded for delivery as Envelope C feed. For the purposes of this DQO, these analytes are referred to as the "discriminating" analytes.

Table 4-5. High-Level Waste Feed Non-Volatile Composition Limits (Envelope D)

Non-Volatile Element	Maximum (g/100 g waste oxides)	Non-Volatile Element	Maximum (g/100 g waste oxides)
As	0.16	Pu	0.054
B	1.3	Rb	0.19
Be	0.065	Sb	0.84
Ce	0.81	Se	0.52
Co	0.45	Sr	0.52
Cs	0.58	Ta	0.03
Cu	0.48	Tc	0.26
Hg	0.1	Te	0.13
La	2.6	Th	0.52
Li	0.14	Tl	0.45
Mn	6.5	V	0.032
Mo	0.65	W	0.24
Nd	1.7	Y	0.16
Pr	0.35	Zn	0.42

Table 4-6. High-Level Waste Feed Volatile Composition Limits (Envelope D)

Volatile Components	Maximum g/L
Cl^-	0.33
TIC/CO_3^{2-}	30
NO_2^-	36 (total NO_2^-/NO_3^- as NO_3^-)
NO_3^-	
TOC	11
CN^-	1.6
NH_3	1.6

Table 4-7. High-Level Waste Feed Radionuclide Composition Limits (Envelope D)

Isotope	Maximum Ci/L	Isotope	Maximum Ci/L	Isotope	Maximum Ci/L
^{3}H	6.5E-05	^{129}I	2.9E-07	^{238}Pu	3.5E-04
^{14}C	6.5E-06	^{137}Cs	1E+01	^{239}Pu	3.1E-03
^{60}Co	1E-02	^{152}Eu	4.8E-04	^{241}Pu	2.2E-02
^{90}Sr	1E+01	^{154}Eu	5.2E-02	^{241}Am	9E-02
^{99}Tc	1.5E-02	^{155}Eu	2.9E-02	$^{243+244}Cm$	3E-03
^{125}Sb	3.2E-02	^{233}U	9E-07		
^{126}Sn	1.5E-04	^{235}U	2.5E-07		

Table 4-8. Operating Specifications from OSD-T-151-00007, Rev. H-21 (PHMC 1998)

If the NO_3^- Conc. Is (molar)	Then the OH^- and NO_2^- Limits are (molar)
≤ 1.0 M	$0.01 < [OH^-] < 5.0$ M (8.0 M if T < 167° F) $0.011 < [NO_2^-] < 5.5$ M $[NO_3^-]/([OH^-] + [NO_2^-]) < 2.5$
1.0 to 3.0 M	$0.1*[NO_3^-] < [OH^-] < 10$ M $[NO_2^-] + [OH^-] \geq 0.4*[NO_3^-]$
3.0 to 5.5 M	$0.3 < [OH^-] < 10$ M $[NO_2^-] + [OH-] \geq 1.2$ M

Table 4-9 shows the analytes that require analyses, suggested analytical methods, and the quality control requirements. The elements marked with (TRU) and total alpha are required to determine the total transuranic radionuclides so a comparison can be made with the envelope limit for TRU (see Table 4-4).

Table 4-9. Quality Control Parameters. (3 sheets)

Analytes	Suggested Analytical Technique	QC Acceptance Criteria		
		LCS % Recovery [1]	Spike % Recovery [2]	Duplicate RPD [3]
Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cs, Cu, Cr, Fe, La, Mg, Mn, Mo, Na, Nd, Ni, P, Pb, Pd[7], Pu, S, Sb, Se, Si, Sr, Tc, Ta, Th, Ti, Tl, U, V, W, Zn, Zr	ICP/AES	80 -120%	75 - 125%	<20%
K, Li, Pm, Pr, Rb, Rh[7], Ru[7], Te	ICP/MS	80 - 120%	70 - 130%	<20%
^{60}Co, ^{125}Sb	GEA	80 - 120%	N/A[5]	<20%
^{129}I, ^{126}Sn, ^{233}U, ^{235}U	ICP/MS	80 - 120%	70 - 130%	<20%
^{99}Tc	ICP/MS and isotopic specific separation/ AEA	80 - 120%	70 - 130%	<20%
Hg	CVAA	80 - 120%	75 - 125%	<20%
NO_2^-, NO_3^-, F^-, Cl^-	ISE or IC	80 - 120%	75 - 125%	<20%
OH^-	Potentiometric titration	80 -120%	N/A	<20%
^{90}Sr	Isotopic specific separation/beta count	75 - 125%	N/A[4]	<20%
^{14}C	Separation/liq. Scintillation	80 - 120%	75 - 125%	<20%
^{3}H	Separation/liq. Scintillation	80 - 120%	N/A[4]	<20%
^{237}Np (TRU)	ICP/MS	90 - 110%	75 - 125%	<20%
$^{238/239/240/242}Pu$ (TRU)	ICP/MS	80 - 120% ^{239}Pu only	70 - 130% ^{239}Pu only	<20%
$^{241}Pu/Am$ (TRU)	ICP/MS	80 - 120% ^{241}Am only	70 - 130% ^{241}Am only	<20%
^{241}Am (TRU)	Separation/AEA	80 - 120%	N/A[4]	<20%
^{242}Cm (TRU)	See note [6]			
$^{243+244}Cm$ (TRU)	Separation/AEA	NP	N/A[4]	<20%
$^{243}Am/Cm$ (TRU)	ICP/MS	90 - 110%	75 - 125%	<20%
Total Alpha	Proportional counter	70 - 130%	70 - 130%	<20%

Table 4-9. Quality Control Parameters. (3 sheets)

Analytes	Suggested Analytical Technique	QC Acceptance Criteria		
		LCS % Recovery [1]	Spike % Recovery [2]	Duplicate RPD [3]
TIC/CO_3^-	Persulfate and combustion furnace	80 - 120%	75 - 125%	<20%
TOC	Silver catalyzed persulfate and combustion furnace	80 - 120%	75 - 125%	<20%
% solids	Gravimetric	80 - 120%	N/A	<20%

Notes:
AEA = Alpha energy analysis
CVAA = cold vapor atomic absorption
GEA = gamma emission analysis
IC = Ion Chromatography
ICP/AES = Inductively coupled plasma/atomic emission spectroscopy
ICP/MS = ICP/mass spectrometry
ISE = Ion Selective Electrode
N/A = Not applicable
NP = Not performed
QC = Quality control
TIC = total inorganic carbon
TOC = total organic carbon

[1] LCS = Laboratory Control Standard. This standard is carried through the entire method. The accuracy of a method is usually expressed as the percent recovery of the LCS. The LCS is a matrix with known concentration of analytes processed with each preparation and analyses batch. It is expressed as percent recovery; i.e., the amount measured, divided by the known concentration, times 100.

[2] For some methods, the sample accuracy are expressed as the percent recovery of a matrix spike (MS) sample. It is expressed as percent recovery; i.e., the amount measured, less the amount in the sample, divided by the spike added, times 100. One matrix spike is performed/analytical batch samples are batched with similar matrices.

[3] RPD = Relative Percent Difference between the sample and duplicate results. Duplicates will be taken through preparation and analysis. Instrument analysis duplicates cannot be substituted except GEA, which requires no preparation. Sample precision is estimated by analyzing duplicates. Acceptable sample precision is usually <20 percent RPD if the sample result is at least 10 times the instrument detection limit.

$$RPD = (|\text{Result 1 - Result 2}| / \text{average result}) \times 100.$$

[4] MS analyses are not required for this method because a tracer is used to correct for analyte loss during sample preparation and analysis. The result generated using the tracer accounts for an inaccuracy of the method on the matrix. The reported results reflect this correction.

[5] The measurement is a direct reading of the energy and the analysis is not affected by the sample matrix; therefore, an MS is not required.

[6] This isotope can not be quantitated because of the short half-life and correspondingly large specific activity. On the ICP/MS, any mass observed at 242 is assumed to be Pu-242 because of the longer half-life.

[7] Analytical methods for these analytes have not been developed by the 222-s Laboratory.

Table 4-10 (for LAW) and Table 4-11 (for HLW) show minimum reportable quantities (MRQ) for the analytes in this DQO. These values are a guide for determining the required analytical sensitivity for reporting results in support of this DQO and were obtained from the LAW Feed DQO (Wiemers and Miller 1997) and the HLW Feed DQO (Wiemers et al. 1998). These levels provide efficient laboratory operation. Lower MRQ values may be achieved; however, in some cases, this may require additional work by the laboratory at additional cost. The method used for calculating the MRQ values is presented in a letter from the laboratory (Esch 1997). The MRQ in Table 4-10 and Table 4-11 differ from a Practical Quantitation Limit, as it is typically defined, in that the reported MRQ take into account the typical preparation/dilution required for the type of matrices in question. The preparation/dilution is dependent on the amount of solids, the concentration of the highest analyte in a multianalyte method, the concentration of any interfering analytes and/or the dose rate of the samples.

Table 4-10. Minimum Reportable Quantities for LAW. (2 sheets)

Analyte	Minimum Reportable Quantities	Units
Al	3.60E+03	µg/ml
Alpha	7.50E-02	µCi/ml
^{241}Am	3.00E-04	µCi/ml
^{243}Am/Cm	3.20E-03	µCi/ml
Ba	2.60E+01	µg/ml
Ca	1.20E+02	µg/ml
Cd	3.20E+02	µg/ml
Cl^-	9.20E+02	µg/ml
$^{243+244}$Cm	5.00E-02	µg/ml
Cr	2.50E+02	µg/ml
^{137}Cs	8.20E+01	µCi/ml
F^-	1.20E+03	µg/ml
Fe	3.90E+02	µg/ml
^{3}H	to be determined	
Hg	2.00E+00	µg/ml
K	4.90E+03	µg/ml
La	3.00E+01	µg/ml
Na	1.60E+04	µg/ml
Ni	1.20E+02	µg/ml
NO_2^-	1.20E+04	µg/ml

Table 4-10. Minimum Reportable Quantities for LAW. (2 sheets)

Analyte	Minimum Reportable Quantities	Units
NO_3^-	3.50E+04	µg/ml
^{237}Np	3.20E-03	µCi/ml
OH^-	2.50E+04	µg/ml
Pb	9.90E+01	µg/ml
PO_4^-	2.50E+03	µg/ml
^{238}Pu	3.20E-03	µCi/ml
^{239}Pu	3.20E-03	µCi/ml
^{240}Pu	3.20E-03	µCi/ml
^{242}Pu	3.20E-03	µCi/ml
$^{241}Pu/Am$	3.20E-03	µCi/ml
^{90}Sr	8.30E-01	µCi/ml
SO_4^-	7.70E+02	µg/ml
^{99}Tc	8.50E-03	µCi/ml
TIC	2.50E+03	µg/ml
TOC	5.00E+02	µg/ml
U	2.60E+02	µg/ml

Table 4-11. Minimum Reportable Quantities for HLW. (3 sheets)

Analyte	Minimum Reportable Quantities	Units
Ag	5.50E+00	µg/ml
Al	3.60E+03	µg/ml
^{241}Am	3.00E-04	µCi/ml
As	4.00E-01	µg/ml
B	3.00E+01	µg/ml
Ba	2.60E+01	µg/ml
Be	to be determined	
Bi	5.50E+01	µg/ml
^{14}C	2.40E-04	µCi/ml
Ca	1.20E+02	µg/ml
Cd	3.20E+02	µg/ml
Ce	5.50E+01	µg/ml
Cl^-	9.20E+02	µg/ml

Table 4-11. Minimum Reportable Quantities for HLW. (3 sheets)

Analyte	Minimum Reportable Quantities	Units
$^{243+244}Cm$	5.00E-02	µg/ml
CN^-	to be determined	
Co	1.00E-02	µg/ml
^{60}Co	1.00E-02	µCi/ml
Cr	2.50E+02	µg/ml
Cs	5.00E-01	µg/ml
^{137}Cs	8.20E+01	µCi/ml
Cu	5.50E+00	µg/ml
$^{152/154/155}Eu$	1.00E-02	µCi/ml
F^-	1.20E+03	µg/ml
Fe	3.90E+02	µg/ml
^{3}H	7.00E-03	µCi/ml
Hg	2.00E+00	µg/ml
^{129}I	5.80E-06	µCi/ml
K	4.90E+03	µg/ml
La	3.00E+01	µg/ml
Li	5.50E+00	µg/ml
Mg	5.40E+03	µg/ml
Mn	5.50E+00	µg/ml
Mo	3.00E+01	µg/ml
Na	1.60E+04	µg/ml
Nd	5.50E+01	µg/ml
NH_3/NH_4^+	4.50E+01	µg/ml
Ni	1.20E+02	µg/ml
NO_2^-	1.20E+04	µg/ml
NO_3^-	3.50E+04	µg/ml
OH^-	2.50E+04	µg/ml
P	1.10E+02	µg/ml
Pb	9.90E+01	µg/ml
Pd	to be determined	
Pm	to be determined	
Pr	6.00E+00	µg/ml
^{238}Pu	3.20E-03	µCi/ml
^{239}Pu	3.20E-03	µCi/ml

Table 4-11. Minimum Reportable Quantities for HLW. (3 sheets)

Analyte	Minimum Reportable Quantities	Units
^{241}Pu	3.20E-03	µCi/ml
S	5.50E+01	µg/ml
Sb	3.50E+01	µg/ml
Se	5.50E+01	µg/ml
Si	3.00E+01	µg/ml
^{126}Sn	2.00E-03	µCi/ml
^{90}Sr	8.30E-01	µCi/ml
Ta	to be determined	
Te	1.80E+01	µg/ml
^{99}Tc	8.50E-03	µCi/ml
Th	6.00E+00	µg/ml
Ti	5.50E+00	µg/ml
TIC	2.50E+03	µg/ml
Tl	to be determined	
TOC	5.00E+02	µg/ml
U	2.60E+02	µg/ml
^{233}U	6.00E-04	µCi/ml
^{235}U	1.08E-06	µCi/ml
V	3.00E+01	µg/ml
W	6.00E+00	µg/ml
Y	to be determined	
Zn	5.50E+00	µg/ml
Zr	5.50E+00	µg/ml

5.0 DEFINE THE STUDY BOUNDARIES

This DQO is applicable when a proposed waste transfer affects one of the static Phase 1 tanks. This occurs anytime waste is transferred (except when transferred into the staging tank) into or out of the Phase 1 tanks listed in Tables 2-1 and 2-2. This DQO will be in place until the waste in each tank listed in Tables 2-1 and 2-2 is retrieved for treatment and disposal or this DQO is superseded by other documentation.

6.0 DECISION RULES

Decision rules define how to evaluate results and actions required as a result of exceeding an action level.

For the low activity waste (Envelopes A, B, and C), the action levels are the maximum ratio, analyte (mole) to sodium (mole) shown in Table 4-3, and the maximum ratio, radionuclide (Bq) to sodium (mole) shown in Table 4-4. The action limit for the quantity of solids in a waste transfer is 2% (dry weight). The action limits for sodium concentration for the quantity of waste feed is lower limit (3 M) and upper limit (10 M). The action level for Total Alpha is the action level for the TRU shown in Table 4-4. The action levels for the operating specifications from OSD-T-151-00007, Revision H-21 (PHMC 1998) are the limits shown in Table 4-8. The action is taken if the simple mean of the analyses obtained is above or below the limits shown in Table 4-8.

For the high level waste (Envelope D), the action levels are the maximum allowable element content shown in Tables 4-5, 4-6, and 4-7.

The following decision rules cover the questions shown in Section 3.0 and the decision points shown in the logic diagram (Section 3.0).

- If the required data (see: Tables 4-3, 4-4, 4-5, 4-6, 4-7, and 4-8, sodium quantity, and the solids quantity) meet the action level requirements for each analyte or parameter (see above), then the waste may be transferred.

  The decision rule above is true for mixing Envelope B waste with Envelope B waste and mixing Envelope C waste with Envelope C waste only if the identity of the discriminating analytes (the analytes that cause a specific batch of waste to be categorized as Envelope B or C) are the same. If the discriminating analytes are different, then the transfer decision is made by WIC. The potential discriminating analytes for Envelope B waste are Cl, Cr, F, PO_4, and SO_4; the potential discriminating analytes for Envelope C waste are ^{90}Sr and TRU (see Tables 4-3 and 4-4).

- If any of the required data fails to meet the action level requirements or if the discriminating analytes are different in incoming Envelope B or C waste, then the decision to transfer waste into a Phase 1 tank is made by WIC. The transfer decision is made by the WIC after evaluating the effect a transfer would have on the waste presently in the tank.

- If any transfer out of a Phase 1 tank is planned, then the decision to make that transfer is made by WIC after evaluating the effect a transfer would have on the waste remaining in the tank in terms of composition, quantity, or timing.

The requirements for the decisions on waste transfers into or out of a tank made by WIC is not presented here because each case can be different. The transfer decisions made by WIC are based on information that is specific to individual transfers, such as the quantity of waste to be transferred, which component and the amount over the action level, and the contents of the tank.

7.0 SPECIFY LIMITS ON DECISION ERROR

The limits for Envelopes A, B, and C are given in terms of the ratio of moles analyte to mole sodium or Becquerel (Bq) per mole sodium. To form the ratio from the analytical results from the supernate samples, μg/ml and μCi/ml are converted to moles/ml and Bq/ml. Each mean analyte concentration is divided by the mean sodium concentration. These ratios of means are given in Equations 1 and 2.

$$\text{Ratio} = \frac{\text{Mean analyte concentration (moles/mL)}}{\text{Mean sodium concentration (moles/mL)}} \tag{1}$$

$$\text{Ratio} = \frac{\text{Mean analyte concentration (Bq/mL)}}{\text{Mean sodium concentration (moles/mL)}} \tag{2}$$

Let $\overline{Y}$ and $\overline{X}$ be the estimates of the mean moles analyte and mean moles Na and let $c(\overline{Y})$ and $c(\overline{X})$ be the estimates of their relative standard deviations (RSDs). The means and variances are obtained from analysis of variance methods. The RSDs are:

$$c(\overline{Y}) = RSD(\overline{Y}) = \frac{\hat{\sigma}(\overline{Y})}{\overline{Y}}, \text{ and}$$

$$c(\overline{X}) = RSD(\overline{X}) = \frac{\hat{\sigma}(\overline{X})}{\overline{X}},$$

where $\hat{\sigma}$ is the estimate of the standard deviation. An estimate of the ratio R is the ratio of means $\hat{R} = \overline{Y}/\overline{X}$. It is appropriate to assume that $\overline{Y}$ and $\overline{X}$ have a bivariate normal

distribution. Consequently, $\overline{Y} - R\,\overline{X}$ is normally distributed and the ratio

$$\frac{\overline{Y} - R\,\overline{X}}{\sqrt{\hat{\sigma}^2(\overline{Y}) + R^2\,\hat{\sigma}^2(\overline{X}) - 2\,R\,\hat{\sigma}(\overline{X}, \overline{Y})}} = t$$

has a Student's t distribution. The upper limit to a one sided 95% CI on R (Cochran 1977, Chapter 6) is:

$$UL(95\%, R) = \frac{\hat{R}}{1 - t^2_{(df,\,0.05)}\,c^2(\overline{X})} \times \left\{1 - t^2\,c(\overline{X}\,\overline{Y}) + t_{(df,\,0.05)}\,Q\right\}$$

$$Q = \sqrt{c^2(\overline{X}) + c^2(\overline{Y}) - 2\,c(\overline{X}\,\overline{Y}) - t^2_{(df,\,0.05)}\left[c^2(\overline{Y})\,c^2(\overline{X}) - c^2(\overline{X}\,\overline{Y})\right]}.$$

In this equation, $c(\overline{X}\,\overline{Y})$ is the estimate of the relative covariance, $t_{(df,\,0.05)}$ is the quantile from Student's t distribution with *df* degrees of freedom for a one-sided 95% CI, and $c(\overline{Y})$ and $c(\overline{X})$ are the estimates of the relative standard deviations of $\overline{Y}$ and $\overline{X}$. The *df* are approximate, they will be the smaller of the *df* for the estimate of the variance of the numerator or of the denominator.

If $\overline{Y}$ and $\overline{X}$ are independent then $c(\overline{X}\,\overline{Y}) = 0$ and the CI reduces to:

$$UL(95\%, R) = \frac{\hat{R}}{1 - t^2_{(df,\,0.05)}\,c^2(\overline{X})} \times$$

$$\left\{1 - t_{(df,\,0.05)} \times \sqrt{c^2(\overline{X}) + c^2(\overline{Y}) - t^2_{(df,\,0.05)}\,c^2(\overline{Y})\,c^2(\overline{X})}\right\}$$

For each analyte, the upper limit (UL) to a 95% CI for a ratio is compared to the envelope limit. If UL is less than the envelope limit, then the analyte satisfies the test criteria. The comparison using UL incorporates spatial and measurement variability in the data. For total alpha the 95% CI is compared to the limit for TRU (see Table 4-4).

For the sodium concentration limits ($3M \leq [Na] \leq 10M$), a two-sided 95% CI will be used.

For the data requirements from OSD-T-151-00007, Rev. H-21 (PHMC 1998) (Table 4-8), the test to determine if the action levels are met is a simple mean of the data analyses.

The limits for Envelope D are given in terms of the concentration of each analyte. In this case, the UL(95%) to a one-sided 95% CI for the mean μ equals

$$UL(95\%, \mu) = \hat{\mu} + t_{(df,\ 0.05)} \times \hat{\sigma}\,(\hat{\mu}),$$

where $\hat{\mu}$ is the mean estimate, $t_{(df,\ 0.05)}$ is the quantile from Student's t distribution with *df* degrees of freedom for a one-sided 95% CI, and $\hat{\sigma}(\hat{\mu})$ is the estimate of the standard deviation of the mean.

For each analyte, the UL to a 95% CI is compared to the envelope limit. If UL is less than the envelope limit, then the analyte satisfies the test criteria. The comparison using UL incorporates spatial and measurement variability in the data.

Any time the UL of one or more analytes is greater than the action level, the transfer decision is made by WIC.

8.0 OPTIMIZE THE DESIGN FOR OBTAINING DATA

A minimum of two samples from different locations and two analyses per sample (primary and duplicate) is required to determine an UL to a 95% CI for any particular analyte. Therefore, a minimum of two samples is required for this DQO. However, if a significant amount (greater than 20,000 gallons) of waste is being transferred within the double shell tank system, the number of samples will be reviewed at the time of the proposed transfer and additional samples may be required if WIC believes the waste is not well mixed.

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