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Data Quality Objectives for Tank Farms Waste Compatibility Program

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Abstract: This report documents the results of the data quality objectives process conducted for the Tank Farms Waste Compatibility program. The appropriate quantity and quality of sample data needed to support the program are prescribed.

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LIST OF TERMS

Abbreviations and Acronyms

ATL	Advanced Technologies and Laboratories International, Inc.
CSER	Criticality Safety Evaluation Report
CI	confidence interval
DOE	U.S Department of Energy
DQO	data quality objective
DST	double-shell tank
DSA	Documented Safety Analysis
Ecology	Washington State Department of Ecology
EPA	U.S Environmental Protection Agency
FG	flammable gas
FGWG	flammable gas waste group
LCL	lower confidence limit
LL	lower limits of CI
LFL	lower flammability limit
ORP	DOE Office of River Protection
OSD	Operating Specifications Document
PAC	protective action criteria
PCB	polychlorinated biphenyl
RSD	relative standard deviation
SD	standard deviation
SST	single-shell tank
T	temperature
TEDE	total effective dose equivalent
TOC	total organic carbon
TRU	Transuranic
TWRWP	tank waste retrieval work plan
UCL	upper confidence limit
UL	upper limits of CI
ULD	unit liter dose
USOF	unit sum of fractions
WAC	Washington Administrative Code
WTP	Waste Treatment and Immobilization Plant

List of Units

Bq/L	Becquerel per liter
BTU/Ci-hr	British thermal units per Curies per hour
BTU/hr	British thermal units per hour
Ci	Curies
Ci/L	Curies per liter
cm	centimeters
°F	degrees Fahrenheit
g	grams
g/kg	grams per kilogram
g/L	grams per liter
g/mL	grams per milliliter
in.	inches
kg	kilogram
m	meter
M	molar or moles per liter
mrem	millirem
ppm	parts per million
rem	Roentgen equivalent in man
Sv/Bq	Sieverts per Becquerel
Sv/L	Sieverts per liter
vol%	volume percent
wt%	weight percent
%	percent
µCi/mL	microcuries per milliliter
µCi/mole	microcuries per mole
µg/g	micrograms per gram
µg/L	micrograms per liter
µg/mL	micrograms per milliliter

1.0 INTRODUCTION

One of the main functions of the River Protection Project is to store Hanford Site waste until the Waste Treatment and Immobilization Plant (WTP) processes the waste and the tank farms are closed. Until the waste is processed and the tank farms are closed, the double-shell tank (DST) system and possibly the single-shell tank (SST) system will receive waste through various waste transfers (see Section 4.0). These operations are under control of the Compatibility Program. The primary goal of the Compatibility Program is to ensure that sufficient controls are in place to prevent the formation of incompatible mixtures that could cause safety, regulatory, programmatic, or operational problems. In order to prevent these potential problems, tank waste information is required.

The programmatic requirements in this data quality objective (DQO) document are established by the Compatibility Program document HNF-SD-WM-OCD-015, *Tank Farm Waste Transfer Compatibility Program*. These programmatic requirements are restated in this DQO to derive data collection requirements. Determinations to transfer waste are based on the criteria found in the program (HNF-SD-WM-OCD-015). If the criteria in HNF-SD-WM-OCD-015 change, this DQO will be revised to reflect these changes.

This document describes the DQO process undertaken to ensure appropriate data (type, quantity, and quality) are collected to support Compatibility Program decisions, which prevent potential waste compatibility problems during waste transfers. The U.S Department of Energy (DOE) requires the use of the DQO process prior to tank sampling activities. The process is implemented in accordance with TFC-ENG-CHEM-C-16, "Data Quality Objectives for Sampling and Analysis," and the U.S Environmental Protection Agency's (EPA's) EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4)*. However, some process modifications from the EPA guidance are commonly made to accommodate project or tank specific sampling constraints.

Because of the multiple issues involved in waste transfers (see Section 4.0), each issue or potential problem is discussed separately in Section 4.0. In addition, a more detailed decision statement and decision rule is presented for that particular issue.

2.0 STATEMENT OF THE PROBLEM

As indicated above, the transfer of waste into or within the tank systems typically involves the commingling of two or more waste streams. Mixing two or more waste types may cause physical and/or chemical reactions, some of which could result in safety or other problems. Therefore, the overall goal is to transfer waste in a safe manner and to prevent the creation of safety, regulatory, programmatic, or operational problems in the receiver tank or the source tank.

Considering the purpose of this DQO, the overall problem statement can be expressed as follows:

> Conduct waste transfers, including waste entering the tank systems and waste transferred within the tank systems, according to the Compatibility Program requirements that prevent waste incompatibilities that could cause safety, regulatory, programmatic, or operational problems.

Regulatory requirements for the treatment, storage, and disposal of waste are found in Washington Administrative Code (WAC) 173-303, "Dangerous Waste Regulations," WAC 173-303-395(1)(b), and the Code of Federal Regulations (CFRs) 40 CFR 264, "Standards for Owners and Operators of Hazardous Treatment, Storage, and Disposal Facilities," section 264.17 and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," section 265.17. The waste is managed so it does not:

- Generate extreme heat or pressure, fire or explosion, or violent reaction
- Produce uncontrolled toxic mists, fumes, dusts, or gases in sufficient quantities to threaten human health or the environment
- Produce uncontrolled flammable fumes or gases in sufficient quantities to pose a risk of fire or explosions
- Damage the structural integrity of the device or facility containing the waste; and/or
- Through other like means, threaten human health or the environment.

Other potential problems covered by this DQO consider source term requirements, management of specific analytes (i.e., polychlorinated biphenyls [PCBs]), and operational requirements (e.g., line plugging) within the DST system. The various potential problems, including safety items, are discussed under specific headings in Section 4.0.

The principal study question that addresses the compatibility problem statement is:

> Does a proposed waste transfer meet the requirements for transfers entering or for transfers within the tank systems?

3.0 DECISION STATEMENTS

Decision statements are created by combining study questions with alternative actions. Using this formula, the decision statement for the study question shown above is:

> Determine whether the waste in a proposed transfer meets the Compatibility Program transfer requirements and allows for an unrestricted transfer, or must be transferred to a specific tank, altered to meet requirements, or the transfer is disallowed.

Each type of issue or potential problem that requires analyses for waste to be transferred is discussed in Section 4.0. This discussion includes specific decision statements and decision rules that address the particular issue or potential problem.

A decision rule is developed as an "if----then" statement that incorporates the parameters of interest, the scale of decision making, the action limit, and the action or actions that would result from the decision.

Commonly, an action limit is a concentration at which point a predetermined action is taken depending on whether the results of the analyses are above or below the specified action limit. To account for uncertainty in the data, analytical results are compared to the action limit at a previously agreed upon statistical confidence interval. Because of the multiple issues addressed in this DQO, confidence intervals may vary for the different issues or, in some instances, uncertainty in the data will be handled by other means. Therefore, the discussion of each issue in Section 4.0 will contain a discussion on the error tolerance for that issue.

As with any requirements, the requirements in this DQO may be temporarily superseded by other criteria or action limits (e.g., Justification for Continued Operations). If a criteria or action limit is permanently changed, this document will be revised.

4.0 DATA INPUTS

This section contains the information required to address the problem statement and the decision statement listed in Section 3.0. In addition, each issue or potential problem requiring waste transfer data will be discussed along with the decisions to be made. Some reasons for sampling and analyzing for waste transfers address potential safety problems (e.g., criticality, etc.), while others address potential operational problems (e.g., line plugging, etc.).

The issues or potential problems, requiring data for waste transfers are:

- Source term
- Flammable gas (FG) (time to the lower flammability limit [LFL] and flammable gas waste group [FGWG])
- Tank bump
- Corrosion mitigation
- Criticality safety
- Organic reactions (organic complexants and organic solvents)
- Chemical compatibility
- PCB management
- Waste feed delivery configuration control (feed control)
- Gel prevention
- Line plugging
- SST retrieval liquids, and
- Emergency Response.

The issues or potential problems listed above are applied to one or more of six types of transfers. The six types of transfers are:

1. DST to DST
2. SST to DST
3. From the 222-S Laboratory or the 242-A Evaporator to DST
4. From DST to the 242-A Evaporator

5. Bulk chemical additions > 10,000 gallons or water additions of >10,000 gallons to DST, and

6. DST waste and large water additions to SSTs.

4.1 REQUIRED ANALYTES

Not all of the analytes are required for each issue listed in Section 4.0 or for each type of waste transfer. Table 4-1 shows the data inputs required by this DQO, the issue or potential problem addressed by the specific data, and the type of transfer requiring the data.

As with any DQO process, existing data may be used if it reflects the current conditions of the receiving tank and the waste being transferred. However, some time restrictions do exist for this DQO (see Section 5.2).

Currently waste can be transferred with a maximum insoluble solids content of 25% by volume. If the insoluble solids content is >25%, the transfer is prohibited unless an evaluation is performed to determine that the proposed transfer is within the analyzed safety basis. Therefore, when insoluble solids are present in concentrations >1% by weight, analytical data are needed. There is one exception in the issues discussed in this DQO. The exception is for the analyses for PCBs. Analytical data for PCBs in solids are required when the solids are ≥0.5% by weight.

Isotopes associated with criticality safety reflect both the data that is required for compliance with the criticality safety controls identified in RPP-7475, *Criticality Safety Evaluation Report for Hanford Tank Farms Facilities*, hereafter referred to as the CSER, and those needed for the update of BBI data and review of fissile to absorbers as required by the criticality safety monitoring program.

Table 4-1. Required Information and Reason for Inclusion (5 Sheets)

Data Input	Problem Addressed (Transfer Type)	Comments
^{238}Pu	Criticality safety (4 for control; 1-6 for monitoring) FG (1, 2, 3, 5) Feed control (1, 2, 3, 5) Emergency response (3)	TRU analyte. Emergency response – type of transfer – inactive tank farm facilities.
$^{239/240}$Pu	Criticality safety (4 for control; 1-6 for monitoring) Source term (1, 2, 3, 4, 6) FG (1, 2, 3, 5) Feed control (1, 2, 3, 5) Emergency response (3)	TRU analytes. Emergency response – type of transfers – inactive tank farm facilities.
^{241}Pu	Criticality safety (4 for control; 1-6 for monitoring) Source term (4) Emergency response (3)	Emergency response – type of transfers – inactive tank farm facilities.

Table 4-1. Required Information and Reason for Inclusion (5 Sheets)

Data Input	Problem Addressed (Transfer Type)	Comments
^{242}Pu	Criticality safety (4 for control; 1-6 for monitoring)	
^{233}U	Criticality safety (1-6 for monitoring) Feed control (1, 2, 3, 5)	Type 4 transfers include evaporator staging within the DST system. Feed control tanks group 1[(a)].
^{235}U	Criticality safety (1-6 for monitoring) Feed control (1, 2, 3, 5)	Type 4 transfers include evaporator staging within the DST system. Feed control tanks group 1[(a)].
^{238}U	Criticality safety (1-6 for monitoring) Feed control (1, 2, 3, 5)	Feed control tanks group 1[(a)].
^{241}Am	Source term (1, 2, 3, 4, 6) FG (1, 2, 3, 5) Emergency response (3)	TRU analyte. Emergency response – type of transfers – inactive tank farm facilities.
^{237}Np	Feed control (1, 2, 3, 5) Emergency response (3)	TRU analyte. Emergency response – type of transfers – inactive tank farm facilities.
^{243}Cm	Feed control (1, 2, 3, 5)	TRU analyte.
^{244}Cm	Feed control (1, 2, 3, 5) Emergency response (3)	TRU analyte. Emergency response – type of transfers – inactive tank farm facilities.
^{154}Eu	Emergency response (3)	Emergency response – type of transfers – inactive tank farm facilities.
^{151}Sm	Emergency response (3)	Will be analyzed as Atomic Mass Unit 151. Type of transfers – inactive tank farm facilities.
^{99}Tc	SST retrieval liquids (6)	
^{60}Co	Emergency response (3)	Type of transfers – inactive tank farm facilities.
Cr	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6) SST retrieval liquids (6)	For evaluation of fissile to absorber monitoring program
Fe	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6)	For evaluation of fissile to absorber monitoring program
Mn	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6)	For evaluation of fissile to absorber monitoring program
Ni	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6)	For evaluation of fissile to absorber monitoring program
pH	Criticality safety (1, 2, 3, 5, 6) Corrosion (1, 2, 3, 5) Source term (1, 2, 3, 6)	For corrosion used to calculate OH^- if pH is <12.5 (RPP-8532[(b)]). Needed for source term OH^- requirements for solids or if pH is <12.5

Table 4-1. Required Information and Reason for Inclusion (5 Sheets)

Data Input	Problem Addressed (Transfer Type)	Comments
Al	Criticality safety (1-6 for monitoring) Source Term (1, 2, 3, 6) FG (1, 2, 3, 5, 6) Line plugging (1, 2, 3, 4, 5, 6)	For evaluation of fissile to absorber monitoring program FG criteria applied to supernatant and interstitial liquids only. Required for line plugging if liquid density is ≥1.35 g/mL or there is >5% solids.
$\%H_2O$	FG (1, 2, 3, 5, 6) PCB (1, 2, 3, 4, 6) Organic reactions (1, 2, 3, 4, 6)	Wt % H_2O for the PCB issue is needed when analyzing solids only. Needed to report PCB concentrations in solids on a dry weight basis.
^{90}Sr	FG (1, 2, 3, 5, 6) Tank bump (1, 2, 3, 5) Source term (1, 2, 3, 4, 6) Feed control (1, 2, 3, 5) Emergency response (3)	^{90}Y is obtained with the ^{90}Sr analysis, however, ^{90}Y is only required for source term. FG criteria applied to supernatant and solids only. Tanks in feed control group 4[(a)]. Emergency response – type of transfers – inactive tank farm facilities.
^{90}Y	Source term (1, 2, 3, 4, 6) Emergency Response (3)	^{90}Y is obtained with the ^{90}Sr analysis.
^{137}Cs	FG (1, 2, 3, 5, 6) Tank bump (1, 2, 3, 5) Source term (1, 2, 3, 4, 6) Emergency response (3)	FG criteria applied to supernatant and solids only. Emergency response – type of transfers – inactive tank farm facilities.
TOC	Source term (1, 2, 3, 6) FG (1, 2, 3, 5, 6)	FG criteria applied to supernatant and interstitial liquids only.
TIC	Source term (1, 2, 3, 6)	Used for source term CO_3^{2-} requirements.
NO_2^-	Corrosion (1, 2, 3, 5) Source Term (1, 2, 3, 6) FG (1, 2, 3, 5, 6) SST retrieval liquids (6)	FG criteria applied to supernatant and interstitial liquids only.
NO_3^-	Corrosion (1, 2, 3, 5) Source Term (1, 2, 3, 6) FG (1, 2, 3, 5, 6)	FG criteria applied to supernatant and interstitial liquids only.
Tank Temperature: dome space and waste	FG (1, 2, 3, 5, 6) Corrosion (1, 2, 3, 5)	Temperature required in the receiver tank.
Tank Volume: supernatant and sludge	FG (1, 2, 3, 5, 6) Tank bump (1, 2, 3, 5) Emergency response (3)	Emergency response – type of transfers – inactive tank farm facilities.
Liquid Density	FG (1, 2, 3, 5, 6) Line plugging (1, 2, 3, 4, 5, 6)	Supernatant and interstitial liquids only.
Volume % settled solids	Line plugging (1, 2, 3, 4, 5, 6)	
Density	Source term (1, 2, 3, 6) Tank bump (1, 2, 3, 5) FG (1, 2, 3, 5, 6)	Density is required to calculate µCi/mL when analyzing solids for source term.

Table 4-1. Required Information and Reason for Inclusion (5 Sheets)

Data Input	Problem Addressed (Transfer Type)	Comments
Na	Source term (1, 2, 3, 6) FG (1, 2, 3, 5, 6) Feed control (1, 2, 3, 5) Line plugging (1, 2, 3, 4, 5, 6)	FG criteria applied to supernatant only. Tanks in feed control group 4[(a)]. Required for line plugging if liquid density is ≥1.35 g/mL or there is >5% solids.
OH^-	Corrosion (1, 2, 3, 5) Source term (1, 2, 3, 6) FG (1, 2, 3, 5, 6) Line plugging (1, 2, 3, 4, 5, 6)	For corrosion, calculated from pH if pH is <12.5 (RPP-8532[(b)]). FG criteria applied to supernatant only. Required for line plugging if liquid density is ≥1.35 g/mL or there is >5% solids.
Cl^-	Source term (1, 2, 3, 6)	
SO_4^{2-}	Source term (1,2,3,6)	
PO_4^{3-}	Phosphate rule (1, 2, 3, 5, 6) Source term (1, 2, 3, 6) Line plugging (1, 2, 3, 4, 5, 6) Gel prevention (1, 2, 3, 4, 5, 6)	Required for line plugging if liquid density is ≥1.35 g/mL or there is >5% solids.
CO_3^{2-}	Source term (1, 2, 3, 6)	TIC analysis satisfies this requirement.
Ag	Source term (1, 2, 3, 6)	
As	Source term (1, 2, 3, 6)	
Be	Source term (1, 2, 3, 6)	
Bi	Source term (1, 2, 3, 6)	
Ca	Source term (1, 2, 3, 6)	
Cd	Source term (1, 2, 3, 6)	
Co	Source term (1, 2, 3, 6)	
Hg	Source term (1, 2, 3, 6)	
K	Source term (1, 2, 3, 6)	
Pd	Source term (1, 2, 3, 6)	Required for solids only.
Rh	Source term (1, 2, 3, 6)	Required for liquids only.
Si	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6)	For evaluation of fissile to absorber monitoring program
Sr	Source term (1, 2, 3, 6)	
Sn	Source term (1, 2, 3, 6)	Required for solids only.
Te	Source term (1, 2, 3, 6)	Required for solids only.
Tl	Source term (1, 2, 3, 6)	Required for solids only.
Th	Source term (1, 2, 3, 6)	Required for solids only.
Pb	Source term (1, 2, 3, 6)	
La	Source term (1, 2, 3, 6)	
W	Source term (1, 2, 3, 6)	Required for liquids only.
Zn	Source term (1, 2, 3, 6)	Required for liquids only.
Zr	Criticality safety (1-6 for monitoring) Source term (1, 2, 3, 6)	For evaluation of fissile to absorber monitoring program
F^-	Source term (1, 2, 3, 6)	FG criteria applied to supernatant only.

Table 4-1. Required Information and Reason for Inclusion (5 Sheets)

Data Input	Problem Addressed (Transfer Type)	Comments
Se	Source term (1, 2, 3, 6)	
U	Source term (1, 2, 3, 6)	
Separable organics	Organic reactions (1, 2, 3, 4, 6)	Required for compliance with organic emission requirements.
Caustic demand test	Corrosion (2, 5)	Tests will be conducted as needed when waste analyses show the OSD chemistry limits are not met.
Energetics	Organic reactions (3, 4)	
PCB	PCB management (1, 2, 3, 4, 6)	
TRU (TRU analytes listed separately above)	Feed control (1, 2, 3, 5)	Tanks in feed control group 4[(a)].
Envelope A	Feed control (1, 2, 3, 5)	Tanks in feed control group 2[(a)].

Notes:
OSD = Operating Specifications Document
TIC = Total inorganic carbon
TOC = Total organic carbon
TRU = Transuranic
[(a)] Feed control tank groups are found in HNF-SD-WM-OCD-015, Appendix A, Table A-1.
[(b)] RPP-8532, *Double-Shell Tanks Chemistry Control Data Quality Objective*.

For the source term issue, analyses of additional constituents for a particular waste stream may be required. If the generator has knowledge of any constituent that is greater than 1% by weight of the waste stream, these constituents must be analyzed as well as those shown in Table 4-1.

4.2 WASTE CHARACTERISTICS CONTROLS

Source term requirements are applied to five of the six types of waste transfers (types 1, 2, 3, 4, and 6). The basis for the source term analytical requirements is to protect assumptions on waste characteristics used to (1) estimate accident consequences and (2) develop controls for flammable gas deflagration due to gas release events by preventing the formation of waste gel in DSTs and SSTs. A more in-depth description of the basis for the source term analytical requirements is found in HNF-IP-1266, *Tank Farms Operations Administrative Controls*, Section 5.9.4 and in HNF-15279, *Technical Safety Requirements for the 242-A Evaporator*.

4.2.1 Source Term Specific Decision Statements

The specific study question for the source term issue during waste transfers can be stated as follows:

> Is the waste in a proposed waste transfer bounded by the source term assumptions used in the Documented Safety Analysis (DSA) (RPP-13033, *Tank Farms Documented Safety Analysis* or HNF-14755, *Documented Safety Analysis for the 242-A Evaporator*)?

Considering the study question, the decision statement for the source term issue can be stated as:

> Determine whether the waste in a proposed waste transfer is below the source term action limit and allows the waste to be transferred as planned, or requires a reevaluation using additional evidence to allow the transfer, chemical adjustment of the waste to meet requirements, or disallows the transfer.

4.2.2 Required Data Inputs and Action Limit

Several types of data are required to determine if the waste to be transferred will meet the source term requirements. The data needed for the radiological source term requirements are ^{90}Sr, ^{90}Y, ^{137}Cs, ^{239}Pu, ^{240}Pu, and ^{241}Am. The data needed for the toxicological source term requirements are shown in Table 4-2. The analytes in Table 4-2 are used to determine the toxicological unit sum of fractions (USOF) evaluations. As can be seen in Table 4-2, the toxicological data input requirements are different for liquid waste and solid waste. In addition, analyses must be performed for any constituent that the generator has knowledge of that is greater than 1% by weight of the waste stream.

Table 4-3 shows the action limits for the radiological source term and toxicological source term for the waste being transferred from the 222-S Laboratory, 242-A Evaporator, DSTs, and SSTs. Table 4-4 shows the action limits for the liquid and solids in the receiving tank after the waste is received. An assessment of the proposed transfer is conducted to see if the transferred waste and the receiving tank will meet the actions limits during and after the transfer is complete.

Table 4-2. Required Analytes for Toxicological Unit Sum of Fractions Evaluations (2 sheets)

Analyte[a]	Liquid	Solid [b]
Aluminum (Al)	X	X
Arsenic (As)	X	X
Beryllium (Be)	X	X
Bismuth (Bi)	X	X
Cadmium (Cd)	X	X
Calcium (Ca)	X	X
Carbonate (CO_3)	X	X
Chloride (Cl)	X	X
Chromium (Cr)	X	X
Cobalt (Co)	X	X
Fluoride (F)	X	X
Hydroxide (OH)	X	X
Iron (Fe)	X	X
Lanthanum (La)	X	X
Lead (Pb)	X	X
Manganese (Mn)	X	X
Mercury (Hg)	X	X
Nickel (Ni)	X	X

Table 4-2. Required Analytes for Toxicological Unit Sum of Fractions Evaluations (2 sheets)

Analyte[a]	Liquid	Solid [b]
Nitrate (NO_3)	X	X
Nitrite (NO_2)	X	X
Palladium (Pd)		X
Phosphate (PO_4)	X	X
Potassium (K)	X	X
Rhodium (Rh)	X	
Selenium (Se)	X	X
Silicon (Si)	X	X
Silver (Ag)	X	X
Sodium (Na)	X	X
Strontium (Sr)	X	X
Sulfate (SO_4)	X	X
Tellurium (Te)		X
Thallium (Tl)		X
Thorium (Th)		X
Tin (Sn)		X
Total Organic Carbon (TOC)	X	X
Tungsten (W)	X	
Uranium (U)	X	X
Zirconium (Zr)	X	X
Zinc (Zn)	X	

Notes:

[a] List of analytes from HNF-IP-1266.

[b] If solids are present at less than 1% by weight, analysis of solids is not required and the liquid components only may be used to calculate the sum of fractions.

Table 4-3. Limiting Tank Farm DSA Source Term Assumptions for Waste Transfers. [a]

Waste Transfers From	ULD Offsite Liquid (Sv/L)	ULD Offsite Solid (Sv/L)	ULD Onsite Liquid (Sv/L)	ULD Onsite Solid (Sv/L)	Sr-90 Liquid (Bq/L)	Sr-90 Solid (Bq/L)	Cs-137 Liquid (Bq/L)	Cs-137 Solid (Bq/L)	USOF PAC-2 Liquid	USOF PAC-2 Solid	USOF PAC-3 Liquid	USOF PAC-3 Solid
222-S Laboratory	1.5E+03	2.9E+05	1.0E+03	2.0E+05	3.0E+09	3.0E+12	7.0E+10	7.0E+10	4.0E+08	5.0E+08	2.0E+07	6.0E+07
242-A Evaporator[b]	3.2E+03		2.15E+03[c]		8.14E+09[c]		5.55E+10[c]		3.0E+08[c]		1.1E+07[c]	
DSTs	1.5E+03	2.9E+05	1.0E+03	2.0E+05	3.0E+09	3.0E+12	7.0E+10	7.0E+10	4.0E+08	5.0E+08	1.3E+07	6.0E+07
SSTs	1.5E+03	2.9E+05	1.0E+03	2.0E+05	3.0E+09	3.0E+12	7.0E+10	7.05E+10	4.0E+08	5.0E+08	1.3E+07	6.0E+07

Bq/L = Becquerel per liter
Sv/L = Sieverts per liter
PAC = Protective Action Criteria
ULD = unit liter dose
USOF = unit sum of fractions

Notes:
[a] This table is reproduced from Table 5.9.4-4 of HNF-IP-1266.
[b] Transfers from the 242-A Evaporator must be compared to both this row and the row for transfers from DSTs.
[c] This value is a volume average composite of liquid and solid source terms calculated as follows:
Composite source term = (volume% liquids x source $term_{liquid}$) + (volume% solids x source $term_{solid}$)

Table 4-4. Limiting Tank Farm DSA Waste Layer Radiological and Toxicological Source Term Assumptions. [a]

Tank	ULD Offsite Liquid (Sv/L)	ULD Offsite Solid (Sv/L)	ULD Onsite Liquid (Sv/L)	ULD Onsite Solid (Sv/L)	USOF PAC-2 Liquid	USOF PAC-2 Solid	USOF PAC-3 Liquid	USOF PAC-3 Solid
241-C-200 SSTs	1.7E+05	1.7E+05	1.0E+03	1.3E+05	4.0E+08	4.5E+08	2.0E+07	8.0E+07
SSTs	1.5E+03	1.7E+05	1.0E+03	1.3E+05	3.5E+08	3.5E+08	1.3E+07	5.5E+07
241-AZ-101	1.5E+03	2.9E+05	4.0E+02	1.9E+05	3.5E+08	5.0E+08	2.0E+07	6.0E+07
DSTs	1.5E+03	1.7E+05	1.0E+03	9.0E+04	3.5E+08	3.5E+08	2.0E+07	2.5E+07

Sv/L = Sieverts per liter
PAC = Protective Action Criteria
ULD = unit liter dose
Note: [a] This table is reproduced from Table 5.9.4-1 of HNF-IP-1266.

The radiological source term limits for type 4 transfers (242-A Evaporator) (see Table 4-6) differ from the other transfer types. Type 4 source term transfer limits are in Ci/L. In addition, an inventory limit (total Ci) is applied. There are no toxicological limits for type 4 transfers.

Source waste is evaluated to verify that the radiological unit liter dose (ULD) of the waste is bounded by the source term assumptions used in the DSA (RPP-13033). For each source waste, this verification is performed by evaluating $^{90}Sr/^{90}Y$, ^{137}Cs, ^{239}Pu, ^{240}Pu and ^{241}Am using the dose conversion factors provided in Table 4-5. Because these isotopes may only account for 95% of the ULDs, the calculated ULDs are divided by 0.95 for comparison to the bounding ULDs provided in Tables 4-3 and 4-4.

Table 4-5. Dose Conversion Factors (Sv/Bq)

Analyte	Onsite (100-m) Receptor	Offsite Receptor
^{90}Sr	3.0 E-08	3.6 E-08
^{90}Y	1.7 E-09	1.4 E-09
^{137}Cs	6.7 E-09	4.6 E-09
Gross Alpha[(a)]	4.2 E-05	4.5 E-05
^{239}Pu[(b)]	3.2 E-05	5.0 E-05
^{240}Pu[(b)]	3.2 E-05	5.0 E-05
^{241}Am	2.7 E-05	4.2 E-05

[(a)] Gross Alpha is used if ^{239}Pu, ^{240}Pu and ^{241}Am are not available.

[(b)] ^{239}Pu and ^{240}Pu analyses using Alpha Energy Analysis are reported as $^{239/240}Pu$.

Source wastes are evaluated to verify that the toxicological USOFs of the waste are bounded by the source term assumptions used in the DSA (RPP-13033). This evaluation is performed by calculating the protective action criteria (PAC), PAC-2, and PAC-3 USOFs for the solid and liquid phases of the waste stream, using equivalent compounds for the analytes shown in Table 4-2 and the methodology described in RPP-30604, *Tank Farms Safety Analyses Chemical Source Term Methodology*. The calculated total USOFs are compared to the bounding USOFs provided in Tables 4-3 and 4-4. The analytes used for calculation of the USOF should adequately represent the waste type being transferred.

Table 4-6 shows the action limits for type 4 transfers (242-A Evaporator). As can be seen in Table 4-6, the type 4 transfer requires an inventory limit as well as a bounding source term limit. The action limits shown in Table 4-6 are from HNF-15279.

Table 4-6. 242-A Evaporator Source Strength Control Inventory Limits

Radionuclide	Bounding Source Term (Ci/L)	Inventory Limits (Ci)
^{90}Sr	2.2E-01	2.18E+04
^{90}Y*	2.2E-01	2.18E+04
^{137}Cs	1.5E+00	1.49E+05
$^{239/240}$Pu	1.6E-04	1.58E+01
^{241}Pu	1.5E-02	1.49E+03
^{241}Am	1.0E-03	9.90E+01
Total Source Term	**1.96E +00**	**1.94E+05**

Ci = Curies

Ci/L = Curies per liter

Note: * Normally not measured, but assumed to be equal to Sr-90 concentration.

4.2.3 Decision Rules

The decision logic addressing the source term issue is addressed in two decision rules shown below. As discussed above, there are different action limits that must be met before waste can be transferred. Although there are different action limits, all must be met (for a specific transfer type) before waste can be transferred without reevaluating the transfer.

The decision rule for ULD and USOF is shown below.

1. If the calculated ULD for ^{90}Sr, ^{90}Y, ^{137}Cs, ^{239}Pu, ^{240}Pu, and ^{241}Am and USOF for constituents in Table 4-2 meet the action limits shown in Tables 4-3 (for transferring the waste) and Table 4-4 (for the receiving tank after the transfer), then the waste can be transferred as planned; otherwise, the transfer must be reevaluated or disallowed.

The decision rule for type 4 transfers is shown below. There are no toxicological limits for type 4 transfers.

2. If the average concentration for each of the constituents (Table 4-6) in a type 4 transfer is less than the indicated action limit, then the waste can be transferred as planned; otherwise, the transfer must be reevaluated or disallowed.

If required, the reevaluation is conducted by the Nuclear Safety and Licensing organization and is subjective. A transfer may take place after the reevaluation if it is determined the waste will not significantly affect the receiving tank or violate the DSA. Waste may also be adjusted to meet the action limit requirements.

4.2.4 Error Tolerance

For the radiological and toxicological analytes, the error tolerance is a simple comparison of the determined ULDs and USOFs of the waste stream to the action limits shown in Tables 4-3 and 4-4.

If raw data are used for a transfer evaluation, a 95% upper confidence limit (UCL) is used to obtain the concentration of a particular analyte. Otherwise, the concentration is obtained from the Best Basis Inventory.

4.3 FLAMMABLE GAS

Flammable gas (FG) generation is a safety issue described in HNF-IP-1266, Section 5.9.1 and in HNF-SD-WM-TSR-006, *Tank Farms Technical Safety Requirement*.

All tank wastes generate FG, and generation rates differ among tanks depending on the composition, temperature, and radiation level of the waste in each tank. In order for FG to be a safety problem, a mixture of gaseous fuel and oxidizer at concentrations greater than the LFL of the gaseous fuel mixture must be present in the tank dome space (time to LFL issue) or gas must be retained below the waste surface in a manner that the gas can be released spontaneously. This is controlled by the FGWG criteria (see Section 4.3.2).

In DSTs, active ventilation prevents FG hazards in the headspace during steady-state operations.

When transferring waste, evaluation is required to prevent flammable gas conditions from developing in the receiver tank and source tank.

4.3.1 Flammable Gas Specific Decision Statements

The flammable gas focus in this DQO is to predict waste transfers (transfer types 1, 2, 3, 5, and 6) that could cause gas generation that would cause an excess of gas in the headspace greater than the action limit or could cause a violation in the FGWG criteria. Therefore, the specific study question for the FG issue can be stated as follows:

> Will a proposed waste transfer cause an unacceptable time to LFL and/or a FGWG criteria violation?

Considering the study question, the decision statement for the FG issue can be stated as:

> Determine whether waste from a proposed transfer meets the time to LFL and the FGWG criteria and allows the waste transfer to take place as planned, additional evaluation prior to a transfer, or requires the waste transfer to be disallowed.

4.3.2 Required Data Inputs and Action Limits

The required data inputs for the liquid and solids are ^{241}Am, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{90}Sr, Total Organic Carbon (TOC), NO_2^-, NO_3^-, OH^-, Al, Na, % water, density in g/mL, waste volume, and waste temperature.

In addition to the data requirements listed above, dome space temperature of the tank is required.

The model used to determine FG generation is developed in RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*. Since the data obtained from the analytes for FG generation are used as input to a model, none of the analytes has an independent action limit. The actual action limit is a combination of the rate of flammable gas generation using the model described in RPP-5926. The action limits are determined assuming loss of the primary tank ventilation. The action limits are the surveillance frequency days shown in HNF-SD-WM-TSR-006. The DST action limits (surveillance frequency in days) are shown in Section 3.7, *DST Flammable Gas Monitoring Control*, the SST action limits are shown in Section 3.2, *SST Steady-State Flammable Gas Control*, and the DST annulus action limits are shown in Section 3.5, *DST Annulus Flammable Gas Control*.

As described in RPP-10006, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*, the waste tanks are assigned to one of three waste groups (A, B, or C). The tank is assigned to a waste group according to the propensity for the tank to retain flammable gas and the potential of the waste to release retained gas by a buoyant displacement gas release event, which is determined using several criteria (see RPP-10006). Therefore, the basic action limit for the buoyant displacement gas release event issue is to prevent the tanks in a waste transfer from becoming a waste group A tank without prior written approval from the DOE Office of River Protection (ORP). Waste transfers into waste group A tanks are prohibited without prior written approval from ORP. A list of tanks with the waste group designation is in Table 5.A-1 of HNF-IP-1266, Appendix 5.A.

A new mechanism for a spontaneous GRE in deep sludge has been postulated, and the tank farm DSA controls that prevent potential GRE flammable gas hazards from large spontaneous buoyant displacement GREs may not preclude a spontaneous GRE from this new mechanism. Compensatory measures will be implemented to address flammable gas hazards from spontaneous GREs in deep sludge (JCO-TF-13-0001, *Justification for Continued Operation for Potential Large Spontaneous Gas Release Event in Deep Sludge*).

4.3.3 Decision Rules

There are two decisions in the decision logic addressing the FG issue; one addressing time to LFL and one addressing waste group designation of the tank. Both decision rules shown below must be met to transfer waste.

1. If after a transfer the FG generation rate allows the headspace in the receiver tank to reach 25% of the LFL before the number of surveillance days shown in HNF-SD-WM-TSR-006 for the DSTs, SSTs, and DST annuluses, then the surveillance requirements (number of days) must be changed to match the projected days to reach 25% of the LFL; otherwise, the transfer can be completed as planned.

2. If a transfer is planned for a waste group A tank or the transfer will cause a tank to become a waste group A tank, then ORP approval is required to transfer the waste; otherwise, the transfer can be completed as planned.

4.3.4 Error Tolerance

The flammable gas requirement addressing the time to reach 25% of the LFL in the tank headspace was developed based on an empirical flammable gas model developed in RPP-5926. Consequently, no additional statistical analysis will be applied to the data. The action limit of 25% of the LFL is conservative. Similarly, the categorization of the tanks into specific waste groups (A, B, or C) is developed in RPP-10006. Therefore, no additional statistical analysis will be applied to the decision addressing the FGWG criteria during a proposed transfer.

4.4 TANK BUMP

There is a potential for a tank bump under certain conditions of waste depth, heat load, and buoyancy ratio. However, the DSA concludes that a tank bump is not a credible accident if certain controls are maintained (RPP-6213, *Hanford Waste Tank Bump Accident and Consequence Analysis*, and RPP-13438, *Technical Basis for the Tank Bump Accident and Associated Representative Hazardous Conditions*). Therefore, prior to a proposed waste transfer, the end state of the receiving tank must be assessed to avoid creating the conditions that would cause a tank bump (OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*, Section 1.7).

Tank bump analysis for 241-AN-106 receiving waste from 241-C-107 is documented in RPP-46868, *Technical Basis for Temperature Control to Prevent Tank Bumps in 241-AN-106*. Analyses indicate that 241-AN-106 fails the tank bump criteria after receiving 241-C-107 waste. Although tank bumps might be possible, a necessary condition is that the supernatant be at or near saturation temperature. Conservative analysis indicates a supernatant temperature of 194 °F (18 °F below saturation) will prevent tank bumps in AN-106 after it receives C-107 waste. Therefore, the supernatant temperature limit is conservatively set at 177 °F for 241-AN-106.

4.4.1 Tank Bump Specific Decision Statements

The end state of the receiving tank waste must meet only one of four conditions shown below to accept transferred waste.

- Total tank heat load <58,000 BTU/hr, or
- Non-convective layer thickness <12 inches, or
- Supernatant layer <39 inches, or
- The non-condensable gas generation rate at saturation temperatures in the non-convective layer is sufficiently low, such that the ratio of the vertical void fraction profile to the neutral buoyant void fraction (buoyancy ratio) is <1.0 [RPP-6213]).

Tank 241-AN-106 can accept transferred waste even if it does not meet one of the four criteria, if a fifth condition of the supernatant temperature <177 °F is met.

Therefore, the decision statement could be written as follows:

> Determine whether the waste to be transferred will cause the receiver tank to exceed all five conditions (non-convective layer is <12 inches, supernatant layer is <39 inches, total tank heat load is <58,000 BTU/hr, the buoyancy ratio is <1.0, and the AN-106 supernatant temperature <177 °F) and requires the waste transfer to be disallowed, transferred to an alternate tank, or requires no action.

4.4.2 Required Data Inputs and Action Limits

The input required to assess the five conditions affecting a tank bump are the depth of solids, depth of the liquids, heat load, buoyancy ratio, and supernatant temperature.

Because the only constituents used from the compatibility waste sampling to determine these inputs are the density of solids and liquids (one of the criteria used in the determination of the buoyancy ratio [RPP-10006]) and the concentrations of ^{90}Sr and ^{137}Cs used to calculate heat load, these data inputs do not have independent action limits.

4.4.3 Decision Rules

For all receiver tanks except AN-106, only one of the four criteria used to address the tank bump issue must be met to transfer waste. For AN-106, there is one additional criterion. The decision rule can be written as follows:

> If the supernatant layer is <39 inches or the non-convective layer is <12 inches or the total tank heat load is <58,000 BTU/hr or there is a buoyancy ratio of <1.0 or the AN-106 supernatant temperature <177 °F, then no action is necessary; otherwise, the waste transfer must be disallowed or transferred to a different tank.

4.4.4 Error Tolerance

The only data input addressing the tank bump issue that can be used to determine a confidence limit is heat load. The heat generation rate is determined by taking the mean concentration of ^{90}Sr and ^{137}Cs in the supernatant and the solids separately. A weighted average of the amount (volume) of the solids and supernatant is used to determine the contribution of each phase to the heat generation rate for the waste in a tank and the waste being transferred to the tank. The ^{90}Sr concentrations are multiplied by 2.28E-02 BTU/(Ci-hr) to determine ^{90}Sr contribution to heat generation rate. The ^{137}Cs concentrations are multiplied by 1.61E-02 BTU/(Ci-hr) to determine the ^{137}Cs contribution to the heat generation rate. If the tank bump decision for the transfer is based on the heat load, a 95% confidence limit can be calculated as shown below.

Based on liquid and solid samples, let the estimates of the mean and standard deviation (*S.D.*) of the mean for ^{90}Sr and ^{137}Cs be denoted by

$$^{90}\text{Sr} : \overline{X}_L, \text{S.D.}(\overline{X}_L) \text{ and } \overline{X}_S, \text{S.D.}(\overline{X}_S)$$

$$^{137}\text{Cs} : \overline{Y}_L, \text{S.D.}(\overline{Y}_L) \text{ and } \overline{Y}_S, \text{S.D.}(\overline{Y}_S)$$

These means and standard deviations may be estimates obtained for a one-way analysis of variance model fit to the data. It is assumed that the concentration data has been multiplied by the appropriate factors so that the units for the means and standard deviations are BTUs per hour.

Let W_L and W_S be the proportions of liquids and solids in the waste. Let the total amount of heat, and its standard deviation, generated by ^{90}Sr and ^{137}Cs be

$$^{90}\mathrm{Sr} : \overline{X}_T = W_L\overline{X}_L + W_S\overline{X}_S,\ \mathrm{S.D.}(\overline{X}_T) = \sqrt{[W_L\mathrm{S.D.}(\overline{X}_L)]^2 + [W_S\mathrm{S.D.}(\overline{X}_S)]^2}$$
$$^{137}\mathrm{Cs} : \overline{Y}_T = W_L\overline{Y}_L + W_S\overline{Y}_L,\ \mathrm{S.D.}(\overline{Y}_T) = \sqrt{[W_L\mathrm{S.D.}(\overline{Y}_L)]^2 + [W_S\mathrm{S.D.}(\overline{Y}_S)]^2}$$

An estimate of the total amount of heat and its standard deviation is

$$T = \overline{X}_T + \overline{Y}_T,\ \mathrm{S.D.}(T) = \sqrt{\mathrm{S.D.}(\overline{X}_T)^2 + \mathrm{S.D.}(\overline{Y}_T)^2}$$

The upper limit to a one-sided 95% confidence interval on the total amount of heat is

$$\mathrm{UCL}(95\%) = T + t_{(0.05,\mathrm{df})} \times \mathrm{S.D.}(T)$$

where $t_{(0.05,\ \mathrm{df})}$ is the appropriate quantile from Student's t-distribution with *df* being the degrees of freedom. The degrees of freedom are determined using Satterwaithe's approximation (Snedecor and Cochran 1982). If UCL (95%) is less than the action limit for maximum amount of heat, then the hypothesis of being greater than the action limit is rejected at the 0.05 level of significance.

4.5 CORROSION MITIGATION

The overall sampling and analytical requirements for the chemistry control portion of the Tank Integrity Program is governed by RPP-8532, *Double-Shell Tanks Chemistry Control Data Quality Objective*. Part of RPP-8532 describes the requirement of preserving tank integrity by maintaining the chemistry (hydroxide ion [OH^-], nitrite ion [NO_2^-], and nitrate ion [NO_3^-]) at specified concentration levels documented in OSD-T-151-00007, Section 1.5. This requirement is also applicable during transfer types 1, 2, 3, and 5 as part of the Compatibility Program requirements.

4.5.1 Corrosion Mitigation Specific Decision Statement

The specific waste transfer study question for the corrosion issue can be stated as follows:

Will a proposed waste transfer cause unacceptable corrosion in pipes and tanks?

Considering the study question, the decision statement for corrosion concerns can be stated as:

> Determine whether a proposed waste transfer will cause unacceptable corrosion in pipes and tanks and requires chemical adjustment of the waste, waste will be transferred to a different tank, or waste can be transferred as planned.

4.5.2 Required Data Inputs and Action Limits

The established inputs to evaluate corrosion potential due to a waste transfer are the hydroxide ion [OH^-], nitrate ion [NO_3^-], nitrite ion [NO_2^-], and pH (where applicable, see Table 4-8). The action limits for OH^-, NO_2^-, and NO_3^- are a set of interrelated conditions presented in the operating specifications document (OSD) OSD-T-151-00007 and shown in Tables 4-7 and 4-8 of this document. All of the conditions that must be met under each scenario are considered the action limit for that particular scenario. Waste temperature is also required to determine the scenario and, therefore, the action limits (see Tables 4-7 and 4-8).

Caustic demand tests may be required for SST waste transferred to DSTs that does not meet tank farm chemistry control requirements. The caustic demand tests are performed to determine the chemistry adjustments required to bring the waste into compliance or maintain the waste within the corrosion control specifications.

4.5.3 Decision Rules

Criteria for transfer types 1 and 2 differ from transfer types 3 and 5 when considering chemistry control for corrosion in the decision logic for transferring waste.

The decision rule for transfer types 1 and 2 can be stated as:

> If the limits to the 95% confidence interval satisfy the OSD chemistry limits for OH^-, NO_2^-, NO_3^-, and pH (where applicable) (Tables 4-7 and 4-8) in the receiving DST after a transfer, then the waste can be transferred as planned; otherwise, another receiver tank must be selected for the waste transfer or the waste must be adjusted to meet the requirements.

The decision rule for transfer types 3 and 5 can be stated as:

> If the limits to the 95% confidence interval satisfy the OSD chemistry limits for OH^-, NO_2^-, and NO_3^- (Table 4-7) in the waste scheduled for transfer, then the waste can be transferred as planned so long as the receiving DST meets the OSD chemistry limits after the transfer; otherwise, the waste chemistry must be adjusted to meet the limits prior to transfer or the transfer disallowed.

Table 4-7. OSD Waste Chemistry Limits Except For Interstitial Liquids In Tanks 241-AN-102, 241-AN-106, 241-AN-107, 241-AY-101 and 241-AY-102

For $[NO_3^-]$ Range	Variable	For Waste Temperature (T) Range		
		T < 167 ºF	167 ºF ≤ T ≤ 212 ºF	T > 212 ºF
$[NO_3^-] \leq 1.0$ M	$[OH^-]$	0.010 M ≤ $[OH^-] \leq 8.0$ M	0.010 M ≤ $[OH^-] \leq 5.0$ M	0.010 M ≤ $[OH^-] < 4.0$ M
	$[NO_2^-]$	0.011 M ≤ $[NO_2^-] \leq 5.5$ M	0.011 M ≤ $[NO_2^-] \leq 5.5$ M	0.011 M ≤ $[NO_2^-] \leq 5.50$ M
	$[NO_3^-] / ([OH^-] + [NO_2^-])$	< 2.5	< 2.5	< 2.5
1.0 M < $[NO_3^-] \leq 3.0$ M	$[OH^-]$	0.1 ($[NO_3^-]$) ≤ $[OH^-] < 10$ M	0.1 ($[NO_3^-]$) ≤ $[OH^-] < 10$ M	0.1 ($[NO_3^-]$) ≤ $[OH^-] < 4.0$ M
	$[OH^-] + [NO_2^-]$	≥ 0.4 ($[NO_3^-]$)	≥ 0.4 ($[NO_3^-]$)	≥ 0.4 ($[NO_3^-]$)
$[NO_3^-] > 3.0$ M	$[OH^-]$	0.3 M ≤ $[OH^-] < 10$ M	0.3 M ≤ $[OH^-] < 10$ M	0.3 M ≤ $[OH^-] < 4.0$ M
	$[OH^-] + [NO_2^-]$	≥ 1.2 M	≥ 1.2 M	≥ 1.2 M
	$[NO_3^-]$	≤ 5.5 M	≤ 5.5 M	≤ 5.5 M

Table 4-8. OSD Waste Chemistry Limits For Interstitial Liquids in Tanks 241-AN-102, 241-AN-106, 241-AN-107, 241-AY-101 and 241-AY-102

Temperature	Variable	Limit
≤ 122 Degrees Fahrenheit	$[NO_2^-]/[NO_3^-]$	≥ 0.32[(a)]
	pH	≥ 10
> 122 Degrees Fahrenheit	Limits in Table 4-7 apply[(b)]	

Notes:

[(a)]The NO_2^-/NO_3^- limit of ≥ 0.32 does not apply to tank 241-AY-102.

[(b)]241-AY-102 chemistry limits apply for temperatures ≤170 degrees Fahrenheit.

4.5.4 Error Tolerance

It is assumed that $[NO_3^-]$, $[NO_2^-]$, and [OH-] will be measured on multiple tank samples. It is also assumed that there is at least one set of duplicate measurements (primary and duplicate) per laboratory batch. Let the measured values of $[NO_3^-]$, $[NO_2^-]$, and [OH-] be denoted by X_{ij}, Y_{ij}, and Z_{ij}, respectively, where i=1, 2,…, denotes the sample number, and j=1,…,n_i denotes the replicate value. Also, let

$$R_{ij} = \frac{X_{ij}}{Y_{ij} + Z_{ij}} = \frac{[NO_3]}{[OH] + [NO_2]},$$

and

$$S_{ij} = Y_{ij} + Z_{ij} = [OH] + [NO_2].$$

The following paragraphs outline the methods used to construct confidence intervals on the mean for the concentration of

$[NO_3^-]$, $[NO_2^-]$, $[OH^-]$, the ratio $[NO_3^-]$ / ($[OH^-]$ + $[NO_2^-]$), and the sum $[OH^-]$ + $[NO_2^-]$.

Each of X_{ij}, Y_{ij}, Z_{ij}, R_{ij}, and S_{ij} are replicate observations from multiple samples. Consequently, a one-way analysis of variance is used to estimate the means and standard deviations of the mean. If the observations are balanced (n_i=n), the analysis of variance estimates of the means are usually the arithmetic means of the observations. If the observations are unbalanced, the estimates of the means will be the restricted maximum likelihood estimates. Let the estimates of the means and standard deviations of the means be denoted by $\overline{X}, \overline{Y}, \overline{Z}, \overline{S}$, and $\overline{R}$ and $SD(\overline{X}), SD(\overline{Y}), SD(\overline{Z}), SD(\overline{S})$, and $SD(\overline{R})$, respectively.

The degrees of freedom are usually the number of samples minus 1. The two sided 100(1-α)% confidence intervals (CIs) for each of $[NO_3^-]$, $[NO_2^-]$, $[OH^-]$, the ratio $[NO_3^-]$ / ($[OH^-]$ + $[NO_2^-]$), and the sum $[OH^-]$ + $[NO_2^-]$ are

$[NO_3^-]$: $\overline{X} - t_{(\alpha,df)} \times SD(\overline{X})$ and $\overline{X} + t_{(\alpha,df)} \times SD(\overline{X})$

$[NO_2^-]$: $\overline{Y} - t_{(\alpha,df)} \times SD(\overline{Y})$ and $\overline{Y} + t_{(\alpha,df)} \times SD(\overline{Y})$

$[OH^-]$: $\overline{Z} - t_{(\alpha,df)} \times SD(\overline{Z})$ and $\overline{Z} + t_{(\alpha,df)} \times SD(\overline{Z})$

$[NO_3^-]$ / ($[OH^-]$ + $[NO_2^-]$): $\overline{R} - t_{(\alpha,df)} \times SD(\overline{R})$ and $\overline{R} + t_{(\alpha,df)} \times SD(\overline{R})$

$[OH^-]$ + $[NO_2^-]$: $\overline{S} - t_{(\alpha,df)} \times SD(\overline{S})$ and $\overline{S} + t_{(\alpha,df)} \times SD(\overline{S})$

where $t_{(df, \alpha)}$ is the appropriate quantile from Student's t-distribution with *df* degrees of freedom and 100(1-α)% confidence. If α=0.05, the intervals are 95% CIs. The symbol α is the percent for the 100(1-α)% confidence statement.

In Table 4-7, there are multiple CIs that must be satisfied. There are four intervals for the first and third [NO_3^-] range and three for the second range. If there is to be 100(1-α)% confidence associated with the combined three or four confidence intervals, then based on Bonferroni's inequality, the individual CIs should have 100(1-α/n)% confidence, where *n* (the number of confidence intervals) is three or four (Snedecor and Cochran 1982, page 116). If *n* is three, the individual CIs should be 98 percent, and if *n* is four, the individual CIs should be 99 percent. The combined [NO_3^-] will jointly have 95 percent confidence, approximately.

For example, for the first range of [NO_3^-] and the first temperature range, four CIs are computed. Let LL and UL denote the lower limits and upper limits of the CIs. The intervals and their acceptance conditionals are shown in Table 4-9.

Table 4-9. Confidence Intervals and Acceptance Conditions

Confidence Interval	Conditions on Interval
One-sided upper 99% CI on [NO_3^-]	UL([NO_3^-])≤1.0
Two-sided 99% CI on [OH^-],	0.01≤LL([OH^-]) and UL([OH^-])≤8.0
Two-sided 99% CI on [NO_2^-]	0.011≤LL([NO_2^-]) and UL([NO_2^-])≤5.5
One-sided upper 99% CI on the ratio [NO_3^-] / ([OH^-] + [NO_2^-])	UL([NO_3^-] / ([OH^-] + [NO_2^-]))≤2.5

If these conditions are all true, then one is approximately 95 percent confident that the limits are satisfied. There are similar tables of LLs and ULs for the other range of limits on [NO_3^-] and temperature.

4.6 CRITICALITY SAFETY

The CSER provides analysis demonstrating that the fissile material operations in the tank farm facilities will remain safely sub-critical for all normal and credible upset conditions. The CSER specifies criticality safety controls that must be implemented to ensure the safety of the fissile material operations.

Table 4-10 provides an overview of the criticality safety controls from the CSER. Both Table 4-1 and Table 4-10 show that criticality safety controls will require some waste analysis for all waste transfer types identified in this DQO.

Table 4-10. Criticality Safety Controls for Waste Transfers

Control	Criteria	Limit	Applicable Transfer Type
RPP-7475, Control #1	No fissile material additions to the tank farms facilities (except for sample receipt at the 222-S Laboratory)	No fissile material additions	N/A
RPP-7475, Control #2	No mixing, mobilization, or retrieval of waste solids in tanks containing greater than 450 g particulate plutonium unless specifically analyzed in a CSER.	No mixing, mobilization, or retrieval	N/A
RPP-7475, Control #3	No activities other than tank characterization are allowed in the inactive underground storage tanks, Catch Tanks, 244-AR Vault Tanks, 244-CR Vault Tanks, and double-contained receiver tanks, except that removal of contaminated intrusion water from the 241-UX-302A catch tank is allowed.	No activities other than tank characterization, except that removal of contaminated intrusion water from the 241-UX-302A catch tank is allowed.	N/A
RPP-7475, Control #4	Operations that would accumulate more than 450 g of particulate plutonium in any one tank are not allowed, except for the addition of the C-102 material to AN-101.	No accumulation of more than 450 g	N/A
RPP-7475, Control #5	All tank additions (other than water) and tank to tank transfers of 3,000 gallons or more shall have pH greater than 5.0.	pH > 5.0	1, 2, 3, 5, 6
RPP-7475, Control #6	A program shall be established that evaluates changes in tank waste inventory estimates to ensure that fissile to neutron absorber mass ratios by waste layer are maintained within safe limits.	Pu/Fe_{Eq} = < 5.99 g/kg[1]; $^{F}U/U$ = < 9.25 g/kg[2]	1 through 6[4]
RPP-7475, Control #7	Feed to the evaporator shall have Pu concentration of less than 0.013 g Pu/L.	< 0.013 g Pu/L[3]	4

Terms: N/A = not applicable, g = grams, kg = kilograms

Notes:

[1] $Pu/Fe_{Eq} = 1{,}000\ g/kg \times m_{Pu}/(m_{Fe} + 5.78m_{Mn} + 0.998m_{Ni} + 0.429m_{Cr} + 0.0701m_{Zr} + 0.0434m_{Si} + 0.00334\ m_{Al})$

In this equation, m_{Pu} is the total Pu mass, which is typically taken as the sum of the masses of the ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu isotopes in unit of grams. The Fe_{Eq} symbol represents the absorber mass in kilograms based on neutronic equivalence with iron mass. The symbols m_{Fe}, m_{Mn}, m_{Ni}, m_{Cr}, m_{Zr}, m_{Si}, and m_{Al} represent the masses of credited neutron absorber materials Fe, Mn, Ni, Cr, Zr, Si and Al, respectively, in grams.

[2] $^{F}U/U = 1{,}000\ g/kg \times (m_{235} + 1.4m_{233})/(m_{235} + m_{233} + m_{238})$

In this equation, the masses of ^{235}U, ^{233}U, and ^{238}U, in grams, are represented by the symbols m_{235}, m_{233}, and m_{238}, respectively.

[3] Pu = total plutonium mass typically taken as the sum of the masses of the ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu isotopes.

[4] Sample results on the fissile materials and neutron absorbers when available will be evaluated by a Criticality Safety Representative for criticality safety monitoring purposes.

4.6.1 Criticality Specific Decision Statements

The specific study question for criticality can be written as follows:

> Will the addition of waste from a proposed transfer to a receiving tank or to the 242-A Evaporator meet the requirements for that type of transfer?

Considering the study questions, the decision statement for criticality can be stated as:

> Determine whether the waste in a proposed transfer meets the criteria limits of the criticality safety controls in the CSER allowing an unrestricted transfer, a reevaluation, or causes the transfer to be disallowed.

4.6.2 Required Data Inputs and Action Limits

The criticality safety controls from the CSER provide two limit criteria that are applicable to this DQO. As Table 4-10 shows, one criterion is a pH > 5.0 limit for tank additions greater than 3,000 gallons other than water (either potable or raw), and the other criterion is on Pu concentration limit on evaporator feed. Each of these criteria has a decision rule identified below that ensures the controlled parameters are within the criticality safety limits prior to authorizing the transfer. The decision rules identified below ensure that the tank wastes will remain safely sub-critical for normal and credible upset conditions based on the RPP-7475 analysis. Possible sources of information used in these decisions are identified in Table 4-11.

Table 4-11. Data Source for Criticality Safety Control Decision Rules

Transfer Type	pH	Pu Concentration (liquid)
1	From BBI	N/A
2	From BBI	N/A
3	Sample results	N/A
4	From BBI	Sample results
5	pH measurement	N/A
6	From BBI	N/A

N/A = not applicable

4.6.3 Decision Rules

As stated above, the criticality safety controls of the CSER provide two limit criteria on transfer pH and Pu concentration. The decision rule for controlling pH in transfer types 1, 2, 3, 5, and 6 is:

> If the 95% lower confidence limit (LCL) for pH is > 5.0 then the waste may be transferred (provided the receiving tank limits are not violated); otherwise, the waste must be adjusted to meet the requirements or the transfer disallowed.

A second decision rule for waste staged for the evaporator feed in transfer type 4 is:

If the average Pu concentration is < 0.013 g Pu/L in the waste of a proposed transfer to the 242-A Evaporator feed, then the waste may be transferred; otherwise, the waste must be adjusted to meet the requirements or the transfer disallowed.

4.6.4 Error Tolerance

It was determined that an average Pu concentration is an appropriate decision parameters for Pu concentration in a Type 4 transfer and a 95% LCL is appropriate for pH in the other transfers identified in this DQO. The lower limit to a one-sided 95% confidence limit on pH is computed using the following equation:

$$\mathrm{LCL}(95\%) = \overline{X} - t_{(0.05,\,df)} \times \mathrm{SD}\,(\overline{X})$$

Where $\overline{X}$ and $\mathrm{SD}(\overline{X})$ are the mean and standard deviation of the mean of the pH values. The LCL can be computed on the pH scale or it can be computed on the anti-log scale and then the LCL transformed to the pH scale. In either case, if the 95% LCL on pH is > 5.0, then the null hypothesis that pH ≤ 5.0 is rejected at the 0.05 level of significance and the transfer may proceed.

4.7 ORGANIC REACTIONS

Two safety issues concerning reactions of organic material are considered for tank waste. The first issue (organic complexant) is discussed in HNF-3588, *Organic Complexant Topical Report*. Organic complexants are chemically reactive materials that could potentially pose two hazards: spontaneous self-accelerating decomposition reactions in the bulk material, and deflagration after being initiated by an ignition source. HNF-3588 summarizes the safety basis used to resolve the organic complexant safety issue. The second issue (organic solvent fire accidents) is discussed in the HNF-4240, *Organic Solvent Topical Report*, along with the justification to close the organic solvent safety issue.

Although both safety issues have been closed, it is necessary to collect data during waste transfers to maintain the tanks in a safe condition and avoid creating a problem in a receiving tank.

4.7.1 Organic Reactions Specific Decision Statement

The specific study questions for the organic reactions during waste transfers can be stated as follows:

Will a proposed waste transfer (type 1, 2, 3, and 6) cause unacceptable storage conditions in the receiving tank from wastes containing organic complexants, organic solvents, or other reactive material?

Will a proposed type 4 transfer meet the requirements for processing waste in the evaporator?

Considering the study questions, the decision statements for organic reactions can be stated as:

> Determine whether a proposed waste transfer (type 1, 2, 3, and 6) will cause unacceptable storage conditions in the receiving tank from organic complexants, organic solvents, or other reactive material and requires the transfer to be disallowed; or allows the waste transfer after further assessment, altering the waste, or providing controls; or allows the waste transfer as planned.
>
> Determine whether a proposed waste transfer (type 4) meets the requirements for processing waste in the 242-A Evaporator, and allows waste to be processed in the 242-A Evaporator or disallows the waste transfer.

4.7.2 Required Data Inputs and Action Limits

Only two data inputs (energetics and separable organics) are necessary to address the organic issue. While the only requirement is for energetics and separable organics, % water is analyzed to help determine if separable organics are present. This information is needed for source waste.

Transfer types 1, 2, and 6 only require visible separable organics observations, while type 3 and 4 transfers require data on energetics as well as visible separable organics observations. The energetics requirements for type 3 transfers is an exotherm/endotherm ratio of <1. Type 4 transfers require an exotherm/endotherm ratio of <1, and no exotherms below 168 ˚F.

4.7.3 Decision Rules

As noted above, requirements differ for type 1, 2 and 6 transfers, type 3 transfers, and type 4 transfers. Therefore, three decision rules are required.

The decision rule for type 1, 2, and 6 transfers can be expressed as:

> If no observable organics are present in the waste to be transferred, then the transfer is allowed; otherwise, the transfer is evaluated against safety concerns for the waste and receiver tank and will be allowed or disallowed depending on the outcome of the evaluation.

Type 3 transfers have two sequential decisions, and the decision rules can be expressed as:

1. If the waste to be transferred contains separable organics, then the transfer is disallowed; otherwise, an evaluation of the ratio of exotherms/endotherms is made.

2. If the 95% UCL of the ratio for exotherms/endotherms is <1 for the incoming waste, then the waste can be accepted; otherwise, the waste is evaluated against safety concerns and will be allowed or disallowed depending on the outcome of the evaluation.

Type 4 transfers have three sequential decisions. The decision rules can be expressed as:

1. If the waste to be transferred contains separable organics, then the transfer is disallowed; otherwise, an evaluation of the exotherms is made.

2. If waste to be transferred contains exotherms below 168 °F, then the transfer is disallowed; otherwise, an evaluation of the ratio of exotherms/endotherms is made.

3. If the ratio for exotherms/endotherms is <1 for the incoming waste, then the waste can be accepted; otherwise, the transfer is disallowed.

The only data input addressing the organic issue that can be used to determine a confidence limit is exothermic/endothermic ratio for transfer type 3. The method for computing the 95% confidence limits for the ratio for exotherms/endotherms is <1 is shown in Section 4.7.4.

4.7.4 Error Tolerance

No statistical evaluation of uncertainty is conducted on the sample analyses for a type 4 transfer. The actual value for each sample is compared to the action limit. If any one sample at any location does not meet the action limit, the alternate actions must be conducted. No additional statistical evaluations are required.

The 95% UCL for the ratio endotherm to exotherm is determined as shown below.

The upper limit to a one-sided 95% confidence interval on the ratio exotherm/endotherm can be computed two ways. The first way is to use a one-way analysis of variance to give an estimate of the mean and standard deviation of exotherm and endotherm. These means and standard deviations are used to construct an approximated confidence limit. That is, if R is the ratio of the mean exotherm and endotherm, then the UCL(95%) is approximately

$$\text{UCL}(95\%, \text{Ratio}) = R(1 + t_{(0.05,\text{df})} \times \text{RSD}(R))$$

where RSD(R) is the square root of the sum of squares of the individual RSDs squared, $t_{(0.05,\, df)}$ is the quantile from Student's t-distribution with *df* degrees of freedom for a one-sided 95% CI. The degrees of freedom are the number of samples minus one. The RSD is the relative standard deviation; it is the standard deviation divided by the mean.

The preferred method is to form the ratio of the individual exotherm and endotherm observations by sample for the primary and duplicate pair for sample one and primary for sample two. Since the data are unbalanced, a one-way analysis of variance model is fit to the ratios of observations to provide an estimate of the mean of ratios $(\bar{r})$ and standard deviation of the mean of ratios $(\text{S.D.}(\bar{r}))$. The correlation between exotherm and endotherm is automatically incorporated into the standard deviation. The upper limit to the one-sided 95% confidence interval on the ratio is then compared to the action limit. That is,

$$UCL(95\%) = \bar{r} + t_{(0.05,\ df)} \times S.D.(\bar{r})$$

where $t_{(0.05,\ df)}$ is the appropriate quantile from Student's t-distribution with *df* degrees of freedom. The degrees of freedom are the number of samples minus one. If UCL(95%) is less than the action limit, then the hypothesis that the ratio exotherm and endotherm is greater than the action limit is rejected at the 0.05 level of significance. The action limits for the exotherm and endotherm ratio is 1.

4.8 CHEMICAL COMPATIBILITY

Waste entering the DST system (type 3 transfers) must be categorized according to reactivity groups as shown in Table 4-11 (US EPA National Service Center for Environmental Publications, Queried 03/12/13, [US EPA, *Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes: A Guidance Manual*, 04/1994, OSWER9938403], This categorization indicates the potential chemical hazards of mixing wastes of different reactivity groups. The reactivity of the waste entering the DST system is to be provided by the waste generator or shipper on a waste profile sheet in accordance with RPP-29002, *Double-Shell Tank Waste Analysis Plan*.

4.8.1 Chemical Compatibility Specific Decision Statements

The decision statement to address waste reactivity can be stated as follows:

> Determine whether the waste in a proposed transfer will create a potential hazard in the receiver tank from mixing wastes from different reactivity groups and requires a safety evaluation, the transfer to be disallowed, or requires no action.

4.8.2 Required Data Inputs and Action Limits

The only data input needed for the waste reactivity issue is the reactivity group numbers of the waste being transferred and the reactivity group numbers of the waste in the receiver tank. The waste in the DST system falls into two reactivity groups; group 10 caustics and group 106 water and mixtures containing water (see Table 4-12).

The reactivity group number of the waste entering the DST system is provided by the waste generator or shipper.

No specific analytical data are required for the waste reactivity issue.

Table 4-12. Waste Reactivity Group Compatibility Matrix

Reactivity Group No.	Reactivity Group Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	101	102	103	104	105	106	107
1	Acids, Mineral, Non-oxidizing	1																																								
2	Acids, Mineral, Oxidizing		2																																							
3	Acids, Organic		I,H	3																																						
4	Alcohols and Glycols	H	H,F	H,P	4																																					
5	Aldehydes	H,P	H,F	H,P		5																																				
6	Amides	H	H,T				6																																			
7	Amines, Aliphatic and Aromatic	H	H,T	H		H		7																																		
8	Azo and Diazo Compounds and Hydrazines	H,I	H,T	H,I	H,I	H			8																																	
9	Carbamates	H,I	H,T						H,I	9																																
10	Caustics	H	H	H		H				H,I	10																															
11	Cyanides	T,G	T,G	T,G					I			11																														
12	Dithiocarbamates	H,G,F	H,G,F	H,G,T		G,T		U	H,I				12																													
13	Esters	H	H,F						H,I		H			13																												
14	Ethers	H	H,F												14																											
15	Fluorides, Inorganic	T	T	T												15																										
16	Hydrocarbons, Aromatic		H,F														16																									
17	Halogenated Organics	H,T	H,F,T					H,T	H,I		H,F	H						17																								
18	Isocyanates	H,I	H,F,T	H,I	H,P			H,P	H,I		H,P,I	H,I	U						18																							
19	Ketones	H	H,F						H,I		H	H								19																						
20	Mercaptans and Other Organic Sulfides	T,G	H,F,T						H,I									H	H	H	20																					
21	Metals, Alkali and Alkaline Earth, Elemental	G,H,F	G,H,F	G,H,F	G,H,F	G,H,F	G,H	G,H	G,H	G,H	G,H	G,H	G,T,H	G,H				H,E	G,H	G,H	G,H	21																				
22	Metals, as Powders, Vapors or Sponges	G,H,F	G,H,F	I,F					H,F,T	U	G,H							H,E	G,H		H,G,F		22																			
23	Metals, as Sheets, Rods moldings, etc.	G,H,F	G,H,F						H,F,I									H,F						23																		
24	Metals and Metal Compounds, Toxic	S	S	S			S	S			S														24																	
25	Nitrides	G,H,F	H,F	H,G	G,H,E	G,H			U	H,I	U	G,H	G,H	G,H				G,H	U	G,H	G,H	E				25																
26	Nitriles	H,T,G	H,T,F	H							U											H,F			S	G,H	26															
27	Nitro Compounds, Organic		H,F,T			H					H,E											H,G,F				H,G,F		27														
28	Hydrocarbons, Aliphatic Unsaturated	H	H,F			H																	H,E						28													
29	Hydrocarbons, Aliphatic Saturated		H,F																											29												
30	Peroxides and Hydroperoxides, Organic	H,I	H,E		H,P	H,I		H,T	H,F,E	H,F,T		H,E,T	H,E,T					H,E	H	E	H,F,T	H,E	H,I		H,I	H,G,F	H,F,T		H,F		30											
31	Phenols and Cresols	H	H,F						H,I										H,F			G,H				G,H					H	31										
	Organophosphates, Phosphorothioates, Phosphorpdithioates	H,T	H,T						U		H,E											H									U		32									
	Sulfides, Inorganic	T,G	H,F,T	T		H			E										H												H,T			33								
34	Epoxides	H,P	H,P	H,P	H,P	U		H,P	H,P		H,P	H,P	U								H,F	H,F	H,F		H,F	H,F					H,F	H,F	U	H,F	34							
101	Combustibles, Flammable Materials, Misc.	H,I	H,F,T																			H,I,F				H,G,F					H,F,T					101						
102	Explosives	H,E	H,E	H,E					H,E		H,E			H,E								H,E	H,E	H,E	E	E					H,E	H,E		H,E	H,E	H,E	102					
103	Polymerizable Compounds	P,H	P,H						P,H		P,H	P,H	U									F,H	F,H	F,H	F,H	F,H					F,H	F,H		F,H			H,E	103				
104	Oxidizing Agents, Strong	H,T		H,T	H,F	H,F	H,F,T	H,F,T	H,E	H,F,T		H,E,T	H,F,T	H,F	H,F		H,F	H,T	H,F,T	H,F	H,F,T	H,F,E	H,F,E	H,F		H,F,E	H,F,T	H,E	H,F	H,F	H,I	H,F	H,F,T	H,F,T	H,F,I	H,F,I	H,E	H,P,T	104			
105	Reducing Agents, Strong	H,G	H,F,T	H,G	H,G,F	G,H,F	G,H	H,G	H,I				H,T	H,F				H,E	G,H	G,H	G,H						H,G	H,E			H,E	G,H	T,G,H		H	G,H	H,E	H,P,G	H,F,E	105		
106	Water and Mixtures Containing Water	H	H																H,I			G,H	G,H		S	G,H								T,G							G,T	106	
107	Water Reactive Substances																																									107

Reactivity Code	Consequences
H	Heat Generation
F	Fire
I	Innocuous
T	Toxic gas generation
G	Flammable gas generation
E	Explosion
P	Violent Polymerization
S	Solubilization of toxic substances
U	May be hazardous but unknown

4.8.3 Decision Rules

The decision rule that addresses the decision statement can be stated as follows:

If the reactivity group of the waste to be transferred indicates a potential hazard with the waste in the receiver tank (reactivity groups 10 and 106), then a technical evaluation is conducted to justify safe waste transfer or the transfer is disallowed; otherwise, no actions are necessary.

4.8.4 Error Tolerance

As can be seen in the other Error Tolerance sections, the purpose of this step is to specify the limits on decision errors. In the case of the waste reactivity issue, specified analytical data is not required, no action limits and, therefore, no decision errors can be established.

4.9 PCB MANAGEMENT

On August 31, 2000, Ecology et al. 2000, *Framework Agreement for Management of Polychlorinated Biphenyls (PCBs) in Hanford Tank Waste* was signed by the DOE, the EPA, and the Washington State Department of Ecology (Ecology). This agreement outlines the management of some DST waste as Toxic Substance Control Act PCB remediation waste based on a risk-based disposal approval option per Title 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," section 761.61 (c). The agreement calls for "Quantification of PCBs in DSTs, SSTs, and incoming waste to ensure that the vitrification plant and other ancillary facilities PCB waste acceptance limits and the requirements of the anticipated risk-based disposal approval are met." In addition to the framework agreement, two risk assessments have been prepared. The first document, RPP-8393, *Double-Shell Tank System PCB Risk Assessment*, evaluated the PCB risk in the DST system. The second risk assessment, RPP-22777, *PCB Risk Assessment for the Mobilization of Single-Shell Tank Solid Waste Using Double-Shell Tank Supernate*, evaluated the PCB risk in using DST supernate to retrieve (sluice) SST waste.

In order to meet the framework agreement and risk assessment conclusions, it is necessary to determine the PCB concentrations in waste entering the DST and SST systems and in transfers between DSTs and SSTs.

The overall PCB sampling and analytical requirements are governed by RPP-7614, *Data Quality Objectives to Support PCB Management in the Double-Shell Tank System*. This DQO addresses PCB sampling and analyses requirements necessary for waste transfers.

4.9.1 PCB Management Specific Decision Statements

The specific study question for the PCB management issue during waste transfers can be stated as follows:

Are the PCB concentrations in the waste of a proposed waste transfer (types 1, 2, 3, 4, or 6) below the limits that allow the waste to be transferred without requiring additional transfer controls or approval by DOE or EPA?

Four decision statements are needed to address the question shown above. These decision statements are needed because the action limits and alternatives are different depending on the type of transfer.

1. Determine whether waste transferred within the DST system or from the SST system to the DSTs (transfer types 1 and 2) contain PCB concentrations above the action limits and require additional transfer controls or require no action.

2. Determine whether waste entering the DST system (transfer type 3) contains PCB concentrations above limits that require transfer controls, DOE approval for acceptance, or requires no action.

3. Determine whether waste transferred to the Evaporator (transfer type 4) contains PCB concentrations above the action limits and disallows the transfer, requires notification and EPA approval, or requires no action.

4. Determine whether waste transferred from a DST to a SST for retrieving SST waste (transfer type 6) contain PCB concentrations above the action limits and requires DOE approval for transfer or requires no action.

4.9.2 Required Data Inputs and Action Limits

The analytes needed to address the PCB management issue is total PCB concentrations in liquids and solids and weight percent H_2O in solids. Total PCB concentrations will be calculated by summing the concentrations of seven Aroclors (1016, 1221, 1232, 1242, 1248, 1254, and 1260) found in a sample. The total PCBs in a sample will be calculated by summing only the detected Aroclors. If no Aroclors are detected, the total PCB concentration is considered the detection limit for the single most common Aroclor expected in the sample. This follows EPA's present procedures for determining the total PCBs in a sample and specified by agreement in a meeting with representatives from EPA Region 10, EPA Manchester Laboratory, Ecology, and DOE. The PCB concentrations in solids will be reported on a dry weight basis. Reporting on a dry weight basis requires the determination of weight percent H_2O when analyzing solids.

For the majority of the issues in this DQO, analyses are required for solids only when the settled solids are ≥1 percent by weight of the waste. However, for the PCB issue, solid analyses are required when the solids are ≥0.5 percent of the total weight of the waste.

The action limits for type 1 and 2 transfers are 50 ppm for solids and 2.9 ppm for liquids. The action limits for a type 3 transfer are 450 ppm for solids and 2.9 ppm for liquids. The bases for these action limits are discussed in RPP-7614. Type 6 transfers have action limits of 0.2 ppm for liquids and 50 ppm for solids. These action limits are from RPP-22777.

The type 4 transfer action limits are 600 µg/L (0.60 ppm) and 6000 µg/L (6.0 ppm) (WCM-127). These action limits are considered sequentially (see the type 4 transfer decision rule).

4.9.3 Decision Rules

The decision logic addressing the PCB management issue requires different action limits for the different types of transfers; one action limit is required for type 1 and 2 transfers, a different action limit for type 3 transfers, a different action limit for type 4 transfers, and a different action limit for type 6 transfers. Therefore, several decision rules are required.

The decision rule addressing transfer types 1 and 2 can be stated as follows:

> If the 95 % UCL for PCB concentrations in a type 1 or 2 waste transfer is <50 ppm for solids and <2.9 ppm for liquids, then the waste can be transferred; otherwise, controls will be applied to maintain the PCB concentrations at <50 ppm for solids and <2.9 ppm for liquids.

The second decision rule, addressing type 3 transfers, can be stated as follows:

> If the 95 % UCL for PCB concentrations in a type 3 waste transfer are between 50 ppm and 450 ppm for solids and <2.9 ppm for liquids, then the waste can be transferred if the receiving tank remains <50 ppm for solids and <2.9 ppm for liquids; otherwise, DOE approval is required prior to the transfer.

Two sequential decisions are required to address type 4 transfers. A decision rule for these decisions can be stated as follows.

> If the 95 % UCL for PCB concentrations in a type 4 waste transfer is between 600 µg/L (0.60 ppm) and 6000 µg/L (6.0 ppm), then the waste can be transferred if an approval is obtained from EPA; otherwise, the transfer is allowed (without EPA approval) if the PCB concentration is <600 µg/L (0.60 ppm) or disallowed if >6000 µg/L (6.0 ppm).

The fourth decision rule, addressing type 6 transfers, can be stated as follows:

> If the 95 % UCL for PCB concentrations in a type 6 waste transfer is <0.20 ppm for liquids and <50 ppm for solids, then the waste can be transferred; otherwise, DOE approval is required prior to the transfer.

Determination of the 95% UCL for this data set is shown in Section 4.9.4.

4.9.4 Error Tolerance

The statistical method for estimating the 95 % UCL for the PCB concentrations in liquid and solid samples to support this document is discussed below.

For liquid samples: Let $\overline{X}_1$, S_1^2, n_1, and df_1 be the sample mean, sample variance, number of observations, and degrees of freedom from the observations from the liquid samples. The upper limit to a one-sided 95% confidence interval on the mean is used to compare the sample results with the action limit. Based on the data from the liquid samples, the upper limit is:

$$UCL(95\%, Liquid) = \overline{X}_1 + t_{(0.05, df_1)} \times \sqrt{S_1^2/n_1}$$

where: $t_{(0.05,df_1)}$ is the appropriate quantile from the Student's t-distribution with df_1 degrees of freedom.

> If UCL(95%, Liquid) is less than the action limit, then the hypothesis that the concentration in liquid waste is greater than the action limit is rejected.

For solid samples: Let $\overline{X}_2$, S_2^2, n_2, and df_2 be the corresponding sample mean, sample variance, number of observations, and degrees of freedom from the observations from the solid samples. The upper limit to a one-sided 95% confidence interval on the mean is used to compare the sample results with the action limits. Based on the data from the solid samples, the upper limit is:

$$UCL(95\%, Solid) = \overline{X}_2 + t_{(0.05, df_2)} \times \sqrt{S_2^2/n_2}$$

where: $t_{(0.05,df_2)}$ is the appropriate quantile from Student's t-distribution with df_2 degrees of freedom.

> If UCL (95%, Solid) is less than the regulatory limit, then the hypothesis that the concentration in solid waste is greater than the action limit is rejected.

4.10 WASTE FEED DELIVERY CONFIGURATION CONTROL

Waste transfers into or out of specific tanks require compatibility evaluations that assesses the transfer's impact on DST space, ability to provide waste to the WTP, and accelerated SST retrieval activities. Therefore, any proposed waste transfers into or out of the tanks listed in Appendix A of HNF-SD-WM-OCD-015 requires a compatibility evaluation for that tank's particular control requirements.

4.10.1 Waste Configuration Specific Decision Statements

The question to be addressed for the waste configuration issue can be stated as follows:

> Does a waste transfer into or out of a designated tank (Appendix A in HNF-SD-WM-OCD-015) comply with the waste feed controls placed on that tank to prevent adversely affecting DST space issues, ability to provide waste to the WTP, or accelerated SST retrieval activities?

The decision statements required to address the question shown above can be written as follows:

> Determine whether a waste transfer into or out of a designated tank (listed in Appendix A in HNF-SD-WM-OCD-015) complies with the waste feed controls placed on that tank and allows the waste transfer to proceed, or requires the acceptance of the transfer impacts to that tank, or requires an alternative transfer plan.

4.10.2 Required Data Inputs and Action Limits

The list of tanks in Appendix A, HNF-SD-WM-OCD-015, is divided into eight feed control groups. The analytical requirements vary from requiring transfers to meet specific analytical controls to using process knowledge and modeling. Feed control groups 1 and 4 have specific data needs and action limits.

Feed control group 1 requires data on ^{233}U, ^{235}U, and ^{238}U. This control requires the combined solid waste to have a ratio of fissile uranium to total uranium ($^{F}U/^{T}U$) of <9.4 g/kg in tank 241-AN-101.

The terms in the $^{F}U/^{T}U$ ratio are defined as follows:

^{F}U = g of (^{235}U mass + 1.5 x ^{233}U mass)
^{T}U = kg of (^{235}U mass + ^{233}U mass + ^{238}U mass)

Feed control group 4 requires data on Transuranic (TRU), ^{90}Sr, and Na. This control requires the TRU/Na ratio to be ≤13.0 µCi/mole or the ^{90}Sr/Na ratio to be ≤1190 µCi/mole in the liquid phase.

The other groups do not have specific data requirements. They are evaluated using the compatibility assessment together with modeling of the effect of the waste transfer on the waste.

4.10.3 Decision Rules

A general decision rule can be applied to a proposed transfer where new analytical data are used to evaluate the impact of the transfer to one of the feed control group tanks. This decision rule can be stated as:

> If the mean of the analytical values meets the feed control requirements for a specific tank (Appendix A in HNF-SD-WM-OCD-015) affected by a proposed waste transfer, then the waste can be transferred; otherwise, notifications will be made and the waste transferred with acceptance of impacts or the transfer plan modified.

4.10.4 Error Tolerance

As can be seen in the other Error Tolerance sections, the purpose of this step is to specify the limits on decision errors. In the case of the waste feed delivery configuration control requirements, the means of the analytical data are considered adequate to make the decisions to

proceed with a proposed waste transfer. Therefore, if the mean of the analytical data meets the appropriate action limit, the waste can be transferred. No additional error calculations are required.

4.11 GEL PREVENTION

Phosphates can cause detrimental solids precipitation or gelling during waste transfers from waste cooling and/or evaporation or in the receiving tank from waste mixing, and this applies to all transfer types. Therefore, it is necessary to evaluate the phosphate concentration, when the concentration is above a specified value (see the decision rule below), before a transfer can take place. The phosphate issue is discussed in RPP-23600, *Phosphate Solubility Technical Basis*.

4.11.1 Gel Prevention Specific Decision Statements

The decision statement to address the issue of the amount of phosphate in the DST system can be stated as follows:

> Determine whether the waste in a proposed waste transfer is above the action limit for PO_4^{-3} and requires further evaluation, or requires no action.

4.11.2 Required Data Inputs and Action Limits

Only one data input is needed to address the gel prevention. The input is the amount of PO_4^{-3} in the waste to be transferred.

The action limit is 0.1 M for PO_4^{-3}.

4.11.3 Decision Rules

The decision rule that addresses the decision statement can be stated as follows:

> If the 95% UCL for PO_4^{-3} is $\leq$0.1 M in the waste of a proposed transfer, then the waste may be transferred as planned; otherwise, the transfer must be evaluated to ensure that detrimental precipitation or gelling of the waste does not occur.

Determination of the 95% UCL for this data set is shown in Section 4.11.4.

4.11.4 Error Tolerance

It is assumed that the PO_4^{-3} concentration data is obtained from at least two samples. It is also assumed that there are primary and duplicate observations from sample one and a single primary observation from sample two. This type of arrangement is called an unbalanced data set. The PO_4^{-3} concentrations are converted to molar concentrations (M).

A one-way analysis of variance model is fit to the unbalanced data. The classification variable is the "sample." The one-way analysis of variance is used to give an estimate of the mean molar concentration and the standard deviation of the mean molar concentration for PO_4^{-3}

The upper limit to the one-sided 95% confidence interval on the mean molar concentration is then compared to the action limit. That is,

$$\text{UCL}(95\%) = \text{mean}(\underline{\text{M}}) + t_{(0.05,\ df_1)} \times \text{S.D.}(\text{mean}(\underline{\text{M}}))$$

where: $t_{(0.05,\ df)}$ is the appropriate quantile from the Student's t-distribution with *df* degrees of freedom. The degrees of freedom are the number of samples minus one. If UCL (95%) is less than the action limit, then the hypothesis that mean molar concentration is greater than the action limit is rejected at the 0.05 level of significance. The action limit for PO_4^{-3} is 0.1 $\underline{\text{M}}$.

4.12 LINE PLUGGING

Line plugging is an operational issue and is discussed in HNF-2728, *Flow Velocity Analysis for Avoidance of Solids Deposition during Transport of Hanford Tank Waste Slurries*. Other considerations of line plugging can be found in RPP-17247, *Dilution and Flushing Requirements to Avoid Solids Precipitation and Deposition during Tank Waste Transfers*. In addition, specific considerations and requirements addressed to prevent line plugging including discussions of the risks of aluminum and phosphate precipitation during transfers are found in TFC-ENG-STD-26, "Waste Transfer, Dilution, and Flushing Requirements" and RPP-23600. The requirements were established to avoid line plugging during all waste transfers.

4.12.1 Line Plugging Specific Decision Statements

The decision statement to address line plugging can be stated as follows:

> Determine whether the waste in a proposed transfer has the potential to cause line plugging and requires an evaluation to demonstrate line plugging will not occur, the transfer to be disallowed, or requires no action.

4.12.2 Required Data Inputs and Action Limits

The primary data inputs for the line plugging issue are percent solids and density of the waste. The action limits for these inputs are 5.0% solids by volume and a liquid density of 1.35 g/mL.

If the waste to be transferred does not meet the action limits, an evaluation of the waste is required to determine or justify why the waste can be transferred without the lines plugging. The evaluation will address the line plugging issue, using parameters such as:

- Concentrations of phosphate or phosphorous, aluminum, sodium, and hydroxide
- The expected carrier liquid density

- The expected particulate solids density
- The expected slurry density during transfer
- The anticipated system flow rate
- The particle size mass distribution or some other analytical measure such as the unhindered solids settling velocity from which an effective particulate solid diameter or diameter distribution can be obtained, and
- The expected carrier liquid viscosity or some other analytical measure (e.g., maximum expected slurry temperature during transfer) that allows the carrier liquid viscosity to be determined.

A complete list of additional information to be considered when making the required evaluation to transfer waste when the liquid density is >1.35 g/mL and the solids are >5.0 % are found in TFC-ENG-STD-26 and RPP-5346, *Waste Feed Delivery Transfer System Analysis*.

4.12.3 Decision Rules

The decision rule that addresses the line plugging decision statement can be stated as follows:

> If the 95% UCL for liquid density is ≤1.35 g/mL or the 95% UCL for settled solids are ≤5.0% by volume in the waste to be transferred, then no actions are necessary; otherwise, an evaluation of the potential for line plugging to occur is conducted.

4.12.4 Error Tolerance

It is assumed that volume percent solids (vol% settled solids) and liquid density are measured on two samples. Let $\overline{X}$ and $S.D.(\overline{X})$ denote the sample mean and standard deviation of the mean for each of the vol% solids and liquid density. The upper limit to a one-sided 95% confidence interval is

$$UCL(95\%) = \overline{X} + t_{(0.05,df)} S.D.(\overline{X})$$

where $t_{(0.05,\ df)}$ is the appropriate quantile from the Student's t-distribution with *df* degrees of freedom. The degrees of freedom are the number of samples minus one. In this case, *df*=1. If UCL(95%) is less than the action limit for vol% or for liquid density, then the hypothesis that the mean is greater than the action limit (greater than 5.0% for vol% solids or greater than 1.35 g/mL for liquid density) is rejected at the 0.05 level of significance.

4.13 SST RETRIEVAL LIQUIDS

The liquid used to sluice a SST must meet concentration requirements for certain constituents. These requirements are based on a tank specific pre-retrieval risk assessment documented in the

tank waste retrieval work plan (TWRWP) (e.g., RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan*).

4.13.1 SST Retrieval Liquids Specific Decision Statements

The specific study question for SST retrieval liquids can be written as follows:

> Do the liquids to be used for SST sluicing meet the constituent concentration requirements found in the TWRWP?

Considering the study question, the decision statement for retrieval liquids can be stated as:

> Determine whether the liquids to be used for SST sluicing meet the constituent concentration limits allowing use for sluicing, or an evaluation is conducted and the TWRWP risk assessment would be updated as necessary.

4.13.2 Required Data Inputs and Action Limits

The specific data required for the SST retrieval liquids are the concentrations of ^{99}Tc, Cr, and NO_2^-. The action limits for these constituents are provided in Table 4-13 for the SSTs in the 241-C tank farm.

Table 4-13. SST Retrieval Liquid Limits

Tank	^{99}Tc Limits (Ci/L)	Cr Limits (g/L)	NO_2 Limits (g/L)
241-C-101	5.84E-05	3.90E-01	4.59E+01
241-C-102	5.84E-05	3.90E-01	4.59E+01
241-C-103	2.67E-05	8.58E-02	1.80E+01
241-C-104	1.21E-04	5.28E-01	8.01E+01
241-C-105	1.68E-04	1.13E+00	9.03E+01
241-C-106	NA	NA	NA
241-C-107	3.08E-05	1.86E-01	3.22E+01
241-C-108	2.41E-05	1.24E-01	1.75E+01
241-C-109	2.93E-05	1.28E-01	1.88E+01
241-C-110	4.77E-05	1.81E-01	4.16E+01
241-C-111	1.21E-04	5.28E-01	8.01E+01
241-C-112	1.21E-04	5.28E-01	8.01E+01

4.13.3 Decision Rules

The decision rule that addresses the retrieval liquids decision statement can be stated as follows:

> If the 95% UCL meets the retrieval liquid limits in Table 4-13, then no actions are necessary; otherwise, the retrieval/closure project manager is notified, an evaluation is conducted, and an update to the TWRWP risk assessment is prepared as necessary.

4.13.4 Error Tolerance

The statistical method for estimating the 95 % UCL for the concentrations of ^{99}Tc, Cr, and NO_2 in liquid samples to support this document is discussed below.

For liquid samples: Let $\overline{X}_1$, S_1^2, n_1, and df_1 be the sample mean, sample variance, number of observations, and degrees of freedom from the observations from the liquid samples. The upper limit to a one-sided 95% confidence interval on the mean is used to compare the sample results with the action limit. Based on the data from the liquid samples, the upper limit is:

$$\text{UCL}(95\%, \text{Liquid}) = \overline{X}_1 + t_{(0.05, df_1)} \times \sqrt{S_1^2/n_1}$$

where: $t_{(0.05,df_1)}$ is the appropriate quantile from the Student's t-distribution with df_1 degrees of freedom.

If UCL(95%, Liquid) is less than the action limit, then the hypothesis that the concentration in liquid waste is greater than the action limit is rejected.

4.14 EMERGENCY RESPONSE

Emergency response actions are determined for potential leaks during waste transfers. These actions have been established for DST and SST waste transfers. However, for smaller catch tanks there is insufficient data to reduce the conservative emergency response actions. Without additional data for the waste in catch tanks, an emergency response for waste spills would be "ALERT" and the maximum ("SITE AREA") emergency response would be required in the event a spray leak occurred during waste retrieval and transfers. The emergency response activities are governed by DOE-0223, "RL Emergency Implementing Procedures."

4.14.1 Emergency Response Specific Decision Statements

The specific study questions for emergency response during waste transfers can be stated as follows:

> What emergency response actions are required during waste retrieval and transfer from a catch tank?

Considering the study question, the decision statement for emergency response concerns can be stated as:

> Determine whether a proposed waste transfer will require an emergency response action of "ALERT," or "SITE AREA," or requires no action.

4.14.2 Required Data Inputs and Action Limits

The specific data required for the Emergency Response issue are ^{137}Cs, ^{154}Eu, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{241}Pu, ^{244}Cm, ^{60}Co, ^{90}Sr, ^{90}Y, and ^{151}Sm (RPP-23226, *Tank Farms Emergency Planning Hazards Assessment*). Analyses will be conducted on the liquid and solids separately. In addition to the analytical data of the listed constituents, a liquid and solids volume of the tank being retrieved are required. These data are used to calculate a total effective dose equivalent.

Presently the 222-S Laboratory does not have a method to analyze for ^{151}Sm. However, the laboratory can analyze for the atomic mass unit 151 using an inductively coupled plasma mass spectrometer. This analysis provides a total concentration of all constituents with an atomic mass unit 151 and will provide a conservative concentration for ^{151}Sm.

There are two limits for emergency response actions (DOE-0223). The first is a total effective dose equivalent (TEDE) of 100 mrem at 100 meters and the second limit is a TEDE of 1 rem at 100 meters.

4.14.3 Decision Rules

There are two decisions that are applied sequentially for emergency response. These decision rules can be stated as:

1. If the calculations show the emergency action level is <100 mrem TEDE at 100 meters, then no action is required; otherwise, the calculation is evaluated for the second action limit in the second decision rule.

2. If the calculations show the emergency action level is ≥100 mrem TEDE at 100 meters and <1 rem at 100 meters, then invoke emergency action response "ALERT;" otherwise, invoke emergency response action "SITE AREA" (≥1 rem TEDE at 100 meters).

4.14.4 Error Tolerance

The purpose of this step is to specify the limits on decision errors. In the case of the emergency response issue, a calculation is made from the analytical data (see Section 4.14.2) to determine the total effective dose equivalent and what emergency response action, if any, would be appropriate if a leak occurred during waste retrieval or transfer. The emergency response organization has determined the actual analytical data from the laboratory are adequate for these calculations and no additional error calculations are required.

4.15 QUALITY CONTROL

Laboratories and/or subcontracted laboratories performing analyses in support of this DQO shall have approved and implemented QA Plans. These QA plans shall meet DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* minimum requirements as the baseline for laboratory quality systems.

At a minimum, a field blank will be utilized for each grab sampling event. The grab sampling field blank shall be lowered into the tank headspace, the stopper removed, and the sample retrieved. For a core sampling event, an equipment rinsate will be collected prior to sampling. Analyses of the field blanks will consist of ion chromatography, inductively coupled plasma/atomic emission spectroscopy, gamma energy analysis, total alpha, TOC, PCB, and pH.

At a minimum, one duplicate analysis will be required for the waste samples in a proposed transfer and in the receiver tank as appropriate. Other laboratory quality control will be conducted in accordance with the laboratory quality assurance plan. Quality control acceptance criteria specific to this DQO are outlined in Table 4-14.

The preferred methods of analysis are SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, or other approved standardized methods.

Table 4-14. Quality Control Parameters. (2 Sheets)

Analytes	Quality Control Acceptance Criteria			
	LCS % Recovery[a]	Spike % Recovery[b]	Duplicate RPD[c] Liquids	Duplicate RPD[c] Solids
Ag, Al, As, Be, Bi, Ca Cd, Co, Cr, Fe, K, La, Mn, Ni, Na, Pd, Pb, Rh, Se, Si,, Sn, Sr, Te, Th, Tl, U, W, Zn, Zr	80 – 120	75 – 125	≤20%	≤30%
Cl^-, CO_3^{2-}, F^-, NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}	80 – 120	75 – 125	≤20%	≤30%
^{90}Sr, ^{90}Y	80 – 120	N/A[f]	≤20%	≤30%
^{241}Am, ^{238}Pu, $^{239/240}Pu$	80 – 120	N/A[f]	≤20%	≤30%
^{241}Pu	80 – 120	N/A	≤20%	≤30%
^{242}Pu	80 – 120	75 – 125	≤20%	≤30%
^{99}Tc, ^{233}U, ^{235}U, ^{238}U, ^{237}Np	80 – 120	75 – 125	≤20%	≤30%
^{243}Cm, ^{244}Cm	N/A	N/A	N/A	N/A
^{60}Co, ^{137}Cs[d]	80 – 120	N/A	≤20%	≤30%
^{154}Eu	N/A	N/A	≤20%	≤30%
^{151}Sm (as Atomic mass unit 151)	80 – 120	75 – 125	≤20%	≤30%
Hg	80 – 120	75 – 125	≤20%	≤30%
TOC	80 – 120	75 – 125	≤20%	≤30%

Table 4-14. Quality Control Parameters. (2 Sheets)

Analytes	Quality Control Acceptance Criteria			
	LCS % Recovery[(a)]	Spike % Recovery[(b)]	Duplicate RPD[(c)] Liquids	Duplicate RPD[(c)] Solids
TIC	80 – 120	75 – 125	≤20%	≤30%
PCB	54 – 144[(g)]	51 – 128[(g)]	≤30%	≤30%
OH^-	80 – 120	75 – 125	≤20%	≤30%
$\%H_2O$	80 – 120	N/A	≤20%	≤30%
pH	± 0.1 pH unit	N/A	N/A	N/A
Energetics	80 – 120	N/A	≤30%	≤30%
Density	N/A	N/A	N/A	≤20%
Volume % settled solids	N/A	N/A	N/A	N/A
Separable Organics	N/A	N/A	N/A	N/A

Notes: N/A = Not Applicable, TIC = Total Inorganic Carbon, TOC = Total Organic Carbon

[(a)] LCS = Laboratory Control Sample. This sample 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.

[(b)] For some methods, the sample accuracy is expressed as the percent recovery of a matrix spike 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 per analytical batch. Samples are batched with similar matrices.

[(c)] RPD = Relative Percent Difference between the analytical samples. Analytical precision is estimated by analyzing duplicates taken separately through preparation and analysis. RPD for PCBs may be calculated using matrix spike and matrix spike duplicate results. Acceptable analytical precision is usually ≤20% RPD for liquids and ≤30% for solids if the sample result is at least 10 times the instrument detection limit.

RPD = ((absolute difference between primary and duplicate)/mean) x 100

[(d)] For the purposes of this DQO, ^{137}Cs should be analyzed by gamma energy analysis.

[(e)] Reserved

[(f)] Matrix spike analyses are not required for this method because a carrier or tracer is used to correct for constituent loss during sample preparation and analysis. The result generated using the carrier or tracer accounts for any inaccuracy of the method on the matrix. The reported results reflect this correction.

[(g)] For solids the LCS is 53% – 125% and the spike is 70% – 130%.

Recommendations for ensuring sample integrity prior to analysis are provided in SW-846. The recommendations include type of sample container, holding time, preservation, and zero headspace in samples (for volatile components). These recommendations are generally based on sampling of environmental samples (e.g., soil, ground or river water). The recommendations are difficult to meet for Hanford Site tank waste samples. Because of their highly radioactive nature, extra precautions are used in the sample collection, shipping, and preparation for analysis to minimize radiation exposure to the workers. The SW-846 recommendations are addressed below.

- Type of sample container – When liquid samples are required, they will be obtained using glass bottles with Teflon®[1]-lined lids or Teflon®-lined septum caps as needed. The appropriate bottle size and color is determined by the specific needs of the sampling

[1] Teflon® is a registered trademark of E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware.

event. For example, for extremely radioactive samples, smaller sample bottles may be required to minimize the radiation source. On the other hand, if a sampling event requires a large amount of sample material for a variety of analyses and tests, larger bottles may be used to minimize the number of samples and, therefore, the exposure time to the samplers. In other words, appropriate bottle size is determined by radioactivity of the waste to be sampled and the specific needs of the sampling events.

- Holding time – The extra precautions required to sample Hanford Site tank waste either lengthens the time required for each sampling, shipping, and analysis step or creates additional steps. For example: personnel must wear protective clothing and shielded gloves when collecting samples; samples must be stored and transported in shielded casks; samples are removed from the casks and transferred into shielded hot cells at the laboratory; samples are broken down and sub-sampled for analysis using remote manipulators; and samples are stored and analyzed in a manner consistent with fissile material requirements and personnel exposure control. Therefore, the recommended holding times for some analyses may not be met. However, efforts shall be made to minimize the duration between sampling and analysis of samples.
- Sample Preservation – Sample preservation could be temperature control, chemical preservation, or both. Controlling sample temperature during transport is difficult because samples are shipped in large, heavy, shielded casks. The cost of providing refrigeration capable of handling these casks would be prohibitive. Therefore, cooling of samples during transport is not required by this DQO. Efforts shall be made to maintain temperature of samples when collected. This is particularly important for liquid samples in the winter. Cooling of the samples may cause undesirable precipitation of solids in the sample. Hot cell space is limited and cannot accommodate large refrigeration units. However, limited (i.e., small) refrigeration capability shall be provided in the laboratory for samples for which cooling is critical (e.g., volatile organic compounds, ammonia).
- Chemical preservations are not recommended for the Hanford Site tank waste. Hanford Site tank wastes commonly contain high levels of salt and will precipitate metals when preserved by adding acid. In addition, the waste is maintained at high pH (generally >12). Preserving the samples by adding acid may require a large amount of acid and may alter the chemical and physical characteristics of the waste. This would adversely affect the goal of assessing concentrations and physical properties of the waste, as it exists in the tank
- Zero headspace in sample bottles – To minimize loss of volatile components, SW-846 recommends that the sample bottles contain zero headspace. This recommendation is generally not achievable because of personnel exposure concerns. Upon removing a liquid sample from a tank, the sample bottle is quickly capped and placed in a shielded cask to minimize radiation exposure to the workers. Sampling personnel are not allowed to “top off” the samples. Therefore, a zero headspace is commonly not obtained.

While not all of the above recommendations can be met for every sample, efforts shall be made to minimize the potential impacts and the duration between sampling and analysis of the samples. When analyses have required holding times, the time between sampling the waste and the analysis of the waste will be reported in the data package.

4.15.1 Required Detection Limits

With some exceptions, the detection limits should be one order of magnitude below the action limit of any specific analyte. When an analyte does not have a specific action limit, the laboratory will use the least possible dilution to obtain the lowest practical detection limits for all analyses. Table 4-15 lists the required detection limits specified for this DQO.

The decision logic addressing the PCB management issue requires different action limits for the different types of transfers. Therefore, the detection limits for PCBs in liquids and solids are one order of magnitude below the lowest respective action limit.

For some issues (criticality safety, flammable gas, corrosion, and source term), an analyte does not have an action limit directly related to the concentration. These four issues are discussed below.

For the criticality decisions in this DQO, two limits are applicable: total Pu concentration < 0.013 g/L for Type 4 transfers and pH>5.0 for all other transfers. Detection limits are not applicable for pH measurements. Total plutonium is typically taken as the sum of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu isotopes. The required detection limit for each plutonium isotope is set at one order of magnitude below the limit or 0.0013 g/L.

As can be seen in Table 4-7, the action limit for the corrosion issue is derived from a set of interrelated analytes under different scenarios. It is possible to be within the chemistry limits with an OH^- concentration as low as 0.01 M and a NO_2^- concentration as low as 0.011 M. Therefore, the quantitation limit should be 0.001 M for OH^- and 0.0011 M for NO_2^-. The other analyte included in Table 4-7 is NO_3^-, which has a threshold limit of 0.05 M. This is the lowest value of NO_3^- that is required to be quantified. Therefore, the detection limit for NO_3^- is set at 0.005 M.

In two of the scenarios (NO_3^- concentrations of 1.0 M to 3.0 M and greater than 3.0 M) in Table 4-7, NO_2^- can have a concentration 0.0 and still meet the action limits. However, when NO_3^- undergoes radiolysis, it converts to NO_2^-. Therefore, it is unlikely that NO_2^- would be less than 0.011 (the threshold limit shown above) when NO_3^- is 1.0 M or greater. This is indicated from existing tank waste analyses. For this reason, the threshold limit for NO_2^- is set at 0.011 for this DQO.

In the scenario where NO_3^- is less than or equal to 1.0 M, the indication is that NO_3^- can be 0.0 M. However, 0.0525 M NO_3^- is the lowest value where the waste could potentially be out of compliance. In this scenario, any values of NO_3^- below 0.0525 M would comply with the OSD chemistry limits. The detection limits for OH^-, NO_2^-, and NO_3^- are the same as requested in RPP-8532.

Table 4-15. Required Detection Limits (3 Sheets)

Data Input	Required Detection Limits[b]	Problem Specifying Detection Limit
$^{239/240}Pu$	0.0013 g/L 0.000016 Ci/L	Criticality safety (Type 4 transfer) Source term (Type 4 transfer)
^{233}U	[a]Not Specified	
^{235}U	[a]Not Specified	
^{238}U	[a]Not Specified	
^{238}Pu	0.0013 g/L	Criticality safety (Type 4 transfer)
^{241}Pu	0.0013 g/L 0.0015 Ci/L	Criticality safety (Type 4 transfer) Source term (Type 4 transfer)
^{242}Pu	0.0013 g/L	Criticality safety (Type 4 transfer)
^{99}Tc	8.3E-06 Ci/L	SST retrieval (Type 6 transfer)
Cr	[a]Not Specified	
Fe	[a]Not Specified	
Mn	[a]Not Specified	
Ni	[a]Not Specified	
pH	Not Applicable	
Al	[a]Not Specified	
$\%H_2O$	Not Applicable	
^{90}Sr	0.022 Ci/L	Source term (Type 4 transfer)
^{90}Y	0.022 Ci/L	Source term (Type 4 transfer)
^{137}Cs	0.15 Ci/L	Source term (Type 4 transfer)
^{241}Am	0.00013 Ci/L	Source term (Type 4 transfer)
TOC	[a]Not Specified	
TIC	[a]Not Specified	
NO_2^-	50.6 µg/mL	Corrosion Mitigation
NO_3^-	310 µg/mL	Corrosion Mitigation
Tank Temperature: Dome space and waste	Not Applicable	
Tank Volume: Supernatant and sludge	Not Applicable	
Density	Not Applicable	
Depth of solids (tank)	Not Applicable	
Na	[a]Not Specified	
OH^-	17 µg/mL	Corrosion Mitigation
Se	[a]Not Specified	
U	[a]Not Specified	
Pb	[a]Not Specified	
La	[a]Not Specified	
Zr	[a]Not Specified	

Table 4-15. Required Detection Limits (3 Sheets)

Data Input	Required Detection Limits[b]	Problem Specifying Detection Limit
F^-	[a]Not Specified	
Caustic demand test	Not Applicable	
Ag	[a]Not Specified	
As	[a]Not Specified	
Be	[a]Not Specified	
Bi	[a]Not Specified	
Cd	[a]Not Specified	
K	[a]Not Specified	
Si	[a]Not Specified	
Sr	[a]Not Specified	
Th	[a]Not Specified	
Ca	[a]Not Specified	
Co	[a]Not Specified	
Hg	[a]Not Specified	
Pa	[a]Not Specified	
Rh	[a]Not Specified	
Sn	[a]Not Specified	
Te	[a]Not Specified	
Tl	[a]Not Specified	
W	[a]Not Specified	
Zn	[a]Not Specified	
Zr	[a]Not Specified	
Cl^-	[a]Not Specified	
Energetics	Not Applicable	
Separable organics	Not Applicable	
CO_3^{2-}	[a]Not Specified	
SO_4^{2-}	[a]Not Specified	
PO_4^{3-}	950 µg/mL	Gel Prevention
TRU	[a]Not Specified	
PCB	5.0 µg/g (solids) 0.02 µg/mL (liquids)	PCB management

Notes:

[a] Use the least possible dilution to obtain the lowest practical detection limit.

[b]Where multiple required detection limits are applicable to an analyte, use the lowest detection limit.

TIC = Total inorganic carbon

TOC = Total organic carbon

TRU = Transuranic

Free hydroxide concentration is normally determined by an approved 222-S Laboratory analytical titration method. However, titration results at low OH^- concentrations (< 0.03 M) pose accuracy problems. As a general guideline, when the waste samples have a pH < 12.5, the free OH^- concentration is calculated from the analytical pH measurement. For waste samples with pH > 12.5, the free hydroxide concentration is normally determined by the analytical titration method. Sodium and buffer (aluminum, phosphate, TOC, and carbonate) concentrations and the shape and quality of the potentiometric titration curve are used in the evaluation of the hydroxide and pH data at low OH^- concentrations.

One of the action limits for the flammable gas issue is an action limit on the flammable gas generation. The generation rate is determined from a model that uses data from several analytes (see Section 4.3.2). The general rule of using the least possible dilution to obtain the lowest practical detection limits for these analytes will be applied.

The action limits for the source term issue are a set of interrelated conditions (see Tables 4-3 and 4-4). As can be seen in the tables, the action limits are a set of additive numbers indirectly related to analyte concentrations. In these cases, it would be advantageous to know the analytical concentrations as low as possible particularly when one of the analytes is close to the total action limit (see Tables 4-3, 4-4, and 4-5). Since this is impractical in most cases, the general rule of using the least possible dilution to obtain the lowest practical detection limits for these analytes will be applied.

5.0 BOUNDARIES

This step in the DQO process defines the spatial and temporal boundaries for the required sampling and analyses needed to make the necessary decisions. The spatial boundaries define the physical area to which the decisions will apply and where the samples should be taken. The temporal boundaries describe the timeframe that the data will represent and when the samples should be taken. In addition, this portion of the DQO addresses any sampling constraints.

5.1 SPATIAL AND TEMPORAL BOUNDARIES

The spatial boundaries for the sampling and analyses covered by this DQO include the waste in the DST system and waste entering the DST system. Depending on the issue being addressed (see discussions on the individual issues), data are required on the waste entering the DST system and the waste in the receiving tank.

This DQO is applied each time a transfer is made into or within the DST system. Therefore, this DQO will be applied as long as the waste is actively managed in the DST system.

5.2 SAMPLING CONSTRAINTS

Existing data may be used to evaluate transfers using some time constraints. For transfers within the DST system and tank farm facilities to DSTs, the data must be posted after May 1989 and be representative of the waste, as it presently exists within the tank. New analytical data are required if the waste has been changed through transfers or other additions since the last sampling effort. For generators or shippers outside the tank farms, existing data, up to one year old for the waste batch to be transferred, may be used, providing the waste has not been changed through additions since the last sampling effort.

Sampling events for compatibility will contend with the usual sampling constraints encountered in sampling tank waste (e.g., operational constraints, resource limitations on the number of samples, sample location restrictions, etc.).

Certain additions to waste tanks are unlikely to cause any waste compatibility problems. Water used to pressure test waste transfer pipelines is one example of such an addition. Therefore, the types of additions to the DST system listed below are exempt from waste compatibility assessments. These exemptions apply only to waste generated by the River Protection Project and only to specific issues. The exemptions do not apply to waste entering the DST system from outside generators or shippers (type 3 transfers).

- Up to 10,000 gallons (1,000 gallons for 200 series tanks) of small water accumulations or potentially contaminated water (e.g., process condensate from tanks on active ventilation, cooling water, rain water, snow melt, pipeline flush water, line drainbacks, pipeline pressure test water, de-entrainer flush water, airlift circulator flush water, 242-A Evaporator process condensate, and water/flush water in the evaporator vessel) with no chemicals added except for those used for tank corrosion control (i.e., sodium hydroxide and sodium nitrite).
- Small volumes (< 5 gallons) of non-waste liquids with pH $\geq$ 7 added for a useful purpose such as cleaners, lubricants, and decontaminants.
- Previously evaluated fixatives listed in RPP-11192, *Tank Farms Chemical Compatibility Evaluation*.
- Up to 100 gallons of saltwater used for conductivity testing.

As indicated above, this DQO addresses waste transfers entering DSTs, entering the 242-A evaporator, and waste transfers from DSTs to DSTs and SSTs. However, this DQO will not be applied to transfers from the DST system to the WTP, and the compatibility DQO will not establish requirements that interfere with the safe and efficient transfer of wastes for use as feed. All transfers to WTP will meet the acceptance criteria of the WTP.

Future revisions of the compatibility DQO and DQOs governing the WTP effort will be reviewed to maintain a basis for safe and efficient transfer of wastes.

6.0 DECISION RULES

The DQO process includes development of decision rules, which define the actions to be taken as a result of exceeding an action limit. Usually decision rules require action limits and alternative actions that will be taken if the action limits are exceeded. Because so many issues are addressed in this DQO, the overall decision rule is written in a general fashion and the issue-specific decision rules are discussed in the sections that discuss the specifics of each issue.

The general decision rule that addresses the decision statement in Section 3.0 can be stated as follows:

> If the waste in a proposed transfer and the waste in the receiving tank meet the requirements for each issue, then an unrestricted waste transfer can be conducted; otherwise, the waste must be transferred to a specific tank, altered to meet the transfer requirements, reevaluated using additional criteria, or the transfer disallowed.

7.0 ERROR TOLERANCE

Because so many issues are addressed in this DQO, the overall error tolerance discussion is written in a general fashion. As with other steps in this DQO, error tolerance for each issue is presented in the appropriate sections that discuss the specifics of each issue.

The uncertainty in the DQO process provides an evaluation of the probability of decision error based on an estimation of the mean, variance, and number of samples. The uncertainty evaluation is used to assess the accuracy and precision specified for sample collection and analysis, the level of decision error, and the number of samples required to meet a given decision error rate. While a UCL or LCL of the data will be applied to the action limits in this DQO (where appropriate), a probabilistic sampling design is not being used (see Section 8.0). Although a probabilistic sampling design is not being used, an option always exists to take additional samples to reduce the uncertainty if the UCL or LCL is close to an action limit.

As can be seen in the individual issue discussions, not all action limits are of a nature that a UCL or LCL of the data can be determined. For instance, a lack of data (a subjective evaluation is made) or the information is obtained by other than analytical methods (a visual observation).

If existing data are used, it will be used as is and no additional requirements will be applied.

8.0 SAMPLING DESIGN

Information required by this DQO will be obtained using existing data, when available, if the existing data meet the criteria outlined in this DQO. When new or additional data are required,

sampling requirements depend on the waste being sampled (e.g., waste entering the DST system or waste in a receiver tank).

For waste entering the DST system, generators or shippers are responsible for obtaining the samples and analyses required for the waste scheduled for transfer and preparation of a waste stream profile sheet (RPP-29002).

For waste entering the DST system from outside generators or shippers (type 3 transfers), a minimum of two independent samples is required; the generator or shipper is responsible for obtaining and analyzing these samples according to the sampling and analytical requirements from the Compatibility Program and this DQO and providing a waste stream profile sheet. Transfers from SSTs also require the preparation of waste stream profile sheets (RPP-29002). All samples shall be representative of the waste.

When sampling supernatant (source tank or receiver tank), the number of samples is determined by the depth of the supernatant as shown below.

- If the supernatant is <100 cm (40 in.), one sample will be obtained (plus a duplicate).
- If the supernatant is between 100 cm (40 in.) and 254 cm (100 in.), two samples will be obtained (plus one duplicate) at two different depths that best represent the waste.
- If the supernatant is >254 cm (100 in.), a minimum of three grab samples will be obtained (plus one duplicate) with at least one sample every 254 cm (100 in.).
- In addition to the samples listed above a surface sample is required when sampling a source tank. This sample is required to check for separable organics.

As with the supernatant, the number of solid samples will depend on the depth of the solids with a minimum of a sample and a duplicate sample. If core samples of the solids are obtained, a segment composite will be analyzed from each segment. If only one segment is obtained, each half segment will be analyzed separately.

A duplicate analysis will be conducted on at least one of the samples from both the waste entering the DST system and from the waste in the receiving tank. In addition, a duplicate sample will be taken and analyzed when the receiving tank is sampled. Sampling and analyses will be conducted before the transfer occurs. Detailed information for sampling and analyses is contained in the tank sampling and analysis plan that is prepared prior to a sampling event.

If the results of the analyses indicate the 95 % confidence limit does not meet the action limits, the additional risk can be accepted or additional samples may be obtained to reduce the confidence interval.

In some instances, the Compatibility Program may only require a portion (selected issues) of this DQO to be applied to a specific sampling event. In those instances, the requirements contained in this DQO for that specific issue will be applied to the samples along with other pertinent (e.g., sampling design) requirements contained in this DQO.

9.0 REFERENCES

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *U.S Code of Federal Regulations*, as amended, U.S Environmental Protection Agency, Washington, District of Columbia.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *U.S Code of Federal Regulations*, as amended, U.S Environmental Protection Agency, Washington, District of Columbia.

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *U.S Code of Federal Regulations*, as amended, U.S Environmental Protection Agency, Washington, District of Columbia.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 3, U.S Department of Energy, Office of River Protection, Richland, Washington.

DOE-0223, "RL Emergency Implementing Procedures", as amended, U.S Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, DOE-RL, and ORP, 2000, *Framework Agreement for Management of Polychlorinated Biphenyls (PCBs) in Hanford Tank Waste*, Washington State Department of Ecology, U.S Environmental Protection Agency, U.S Department of Energy, Office of River Protection, and U.S Department of Energy, Richland Operations Office, Richland, Washington.

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4)*, U.S Environmental Protection Agency Quality Systems, Washington, District of Columbia.

HNF-2728, *Flow Velocity Analysis for Avoidance of Solids Deposition during Transport of Hanford Tank Waste Slurries*, as revised, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-3588, *Organic Complexant Topical Report*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-4240, *Organic Solvent Topical Report*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-14755, *242-A Evaporator Documented Safety Analysis*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

HNF-15279, *Technical Safety Requirements for the 242-A Evaporator*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

HNF-IP-1266, *Tank Farms Operations Administrative Controls*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

HNF-SD-WM-OCD-015, *Tank Farm Waste Transfer Compatibility Program*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

HNF-SD-WM-TSR-006, *Tank Farms Technical Safety Requirements*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

JCO-TF-13-0001, 2011, *Justification for Continued Operation for Potential Large Spontaneous Gas Release Event in Deep Sludge,* Washington River Protection Solutions LLC, Richland, Washington.

OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-5346, *Waste Feed Delivery Transfer System Analysis*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-6213, *Hanford Waste Tank Bump Accident and Consequence Analysis*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-7475, *Criticality Safety Evaluation Report for Hanford Tank Farms Facilities*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-7614, *Data Quality Objectives to Support PCB Management In the Double-Shell Tank System*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-8393, *Double-Shell Tank System PCB Risk Assessment*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-8532, *Double-Shell Tanks Chemistry Control Data Quality Objective*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-10006, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-11192, *Tank Farms Chemical Compatibility Evaluation,* as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-13033, *Tank Farms Documented Safety Analysis*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-13438, *Technical Basis for the Tank Bump Accident and Associated Representative Hazardous Conditions*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-17247, *Dilution and Flushing Requirements to Avoid Solids Precipitation and Deposition during Tank Waste Transfers*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-22777, *PCB Risk Assessment for the Mobilization of Single-Shell Tank Solid Waste Using Double-Shell Tank Supernate*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-23226, *Tank Farms Emergency Planning Hazards Assessment*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-23600, *Phosphate Solubility Technical Basis*, as revised, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-29002, *Double-Shell Tank Waste Analysis Plan*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-30604, *Tank Farms Safety Analyses Chemical Source Term Methodology*, as revised, Washington River Protection Solutions LLC, Richland, Washington.

RPP-46868, *Technical Basis for Temperature Control to Prevent Tank Bumps in 241-AN-106*, as, revised, Washington River Protection Solutions LLC, Richland, Washington.

Snedecor, G. W., and W. G. Cochran, 1980, *Statistical Methods*, 7th Edition, Iowa State University Press, Ames, Iowa.

SW-846, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, as amended, U.S Environmental Protection Agency, Washington, District of Columbia.

TFC-ENG-CHEM-C-16, "Data Quality Objectives for Sampling and Analysis," as revised, Washington River Protection Solutions LLC, Richland, Washington.

TFC-ENG-DESIGN-C-25, "Technical Document Control," as revised, Washington River Protection Solutions LLC, Richland, Washington.

TFC-ENG-STD-26, "Waste Transfer, Dilution, and Flushing Requirements," as revised, Washington River Protection Solutions LLC, Richland, Washington.

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

WCM-127, 2004, "Approval of the Toxic Substance Control Act (TSCA) Risk-based Disposal Approval (RBDA) Application for Management of Polychlorinated Biphenyls (PCB) Remediation Waste at the 200 Area Liquid Waste Processing Facilities," (letter from L. J. Iani to J. Hebdon, DOE Richland Operations Office, and J. Rasmussen, DOE Office of River Protection, June 8), U.S Environmental Protection Agency, Seattle, Washington.

US EPA National Service Center for Environmental Publications, Queried 03/12/13, [US EPA, *Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes: A Guidance Manual*, 04/1994, OSWER9938403].