BHI-01374
Rev. 2

Data Quality Objective Summary Report for Inactive Miscellaneous Underground Storage Tanks (IMUSTs) 241-B-361, 241-T-361, 241-U-361, and 270-W

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

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Data Quality Objective Summary Report for Inactive Miscellaneous Underground Storage Tanks (IMUSTs) 241-B-361, 241-T-361, 241-U-361, and 270-W

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Date Published

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EXECUTIVE SUMMARY

The purpose of this data quality objective (DQO) summary report is to support decision-making activities as they apply to the risk assessment/hazard basis for Inactive Miscellaneous Underground Storage Tanks (IMUSTs) 241-B-361, 241-T-361, 241-U-361, and 270-W. Relative risk rankings have been developed for each IMUST managed by the Environmental Restoration Contractor (ERC) and are documented in the *Environmental Restoration Contract (ERC) Management Plan for Inactive Miscellaneous Underground Storage Tanks (IMUSTs)* (BHI 1999). Verification of the IMUST risk assessment/hazard basis for four of the IMUSTs (241-B-361 settling tank, 241-T-361 settling tank, 241-U-361 settling tank, and 270-W neutralization tank) is the main objective for this DQO effort. These tanks represent a comparably high relative risk of the IMUSTs managed by the ERC. Samples will be collected to verify each of the applicable risk ranking categories, as presented in BHI (1999). The project objective is to establish if the existing tank characterization data are sufficient to support the risk assessment/hazard basis of the IMUSTs managed by the ERC.

The primary sampling methodology proposed in this summary report involves the collection and analysis of vapor samples from the 241-U-361 settling tank. In addition, collection of in situ temperature measurements is proposed. The 241-U-361 settling tank has been selected because it contains the greatest volume of sludge and represents high relative risk of the IMUSTs managed by the ERC. The tank is also accessible for sampling. If the data do not support the relative risk rankings for the 241-U-361 settling tank, then sampling of the 241-B-361 settling tank, and 241-T-361 settling tank will be evaluated as presented in this DQO summary report.

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ACRONYMS

AA	alternative action
BHI	Bechtel Hanford, Inc.
CHI	CH2M Hill Hanford, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
ERC	Environmental Restoration Contractor
FY	fiscal year
IMUST	Inactive Miscellaneous Underground Storage Tank
LBGR	lower bound of gray region
LEL	lower explosive limit
ppb	parts per billion
PQL	practical quantitation limit
PSQ	principal study question
RL	U.S. Department of Energy, Richland Operations Office
RSD	relative standard deviation
TOC	total organic carbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence level
VOA	volatile organic analyte
VOC	volatile organic compound

METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

1.0 STEP 1 – STATE THE PROBLEM

The Environmental Restoration Contractor (ERC) manages 25 inactive miscellaneous underground storage tank (IMUSTs) located in the 200 East and 200 West Areas of the Hanford Site for the U.S. Department of Energy (DOE). Historical sampling and operating data have been reviewed and used to develop a relative risk ranking for each tank. The risk rankings are documented in the *Environmental Restoration Contract (ERC) Management Plan for Inactive Miscellaneous Underground Storage Tanks (IMUSTs)* (BHI 1999). Four of the IMUSTs have been selected by the ERC and the U.S. Department of Energy, Richland Operations Office (RL) as having comparably high potential relative risks. These tanks are the 241-B-361 settling tank, 241-T-361 settling tank, 241-U-361 settling tank, and 270-W neutralization tank.

The purpose of this data quality objective (DQO) process is to verify the risk assessment/hazard basis for IMUSTs 241-B-361, 241-T-361, 241-U-361, and 270-W by collecting a limited number of non-intrusive samples from one of the settling tanks.

The 241-B-361, 241-T-361, and 241-U-361 concrete settling tanks were used to collect solid materials from the process waste discharges of the B, T, and U Plant chemical separations facilities, respectively. The 270-W neutralization tank was used to neutralize supernatant waste from the Uranium Trioxide (UO_3) Facility. Based on the relative risk rankings, the 241-U-361 tank has been selected for sampling. This tank has the largest sludge inventory and is considered to have high relative risk ranking of the IMUSTs managed by the ERC. The objective of DQO Step 1 is to use the information gathered from the DQO scoping process and other relevant information to clearly and concisely state the problem to be resolved.

1.1 PROJECT OBJECTIVES

The project objective is to collect sufficient sample data to verify the risk assessment/hazard basis for the 241-U-361 IMUST. This characterization effort will be tied directly to the relative risk rankings presented in the management plan for the IMUSTs (BHI 1999).

1.2 PROJECT ASSUMPTIONS

1. Any sampling/analysis conducted would support verification of the previous hazard assessment. Sampling the tank contents for waste characterization or disposal is not required.

2. The hazard assessment results may influence future decisions regarding the scope and schedule for tank remediation.

3. The historical liquid and sludge samples/analyses and process information will be sufficient to identify tank contaminants of potential concern (COPCs).

4. The hazard assessment categories presented in BHI (1999) will apply to the current assessment (i.e., no new categories will be added).

5. The IMUST management plan (BHI 1999) contains sufficient data and process information to support the current effort.

6. None of the tanks are expected to contain “free” liquid wastes. The expected material is moist/dry sludge.

7. The three settling tanks (241-B-361, 241-T-361, and 241-U-361) are analogous (i.e., the tanks were used for the same purpose, received the same types of materials, currently contain similar waste sludge, and have the same physical structures). The primary difference between the three tanks is the volume of sludge that each tank contains.

8. Tank 270-W was used for neutralization and contains lime solids and soluble contaminants from the same sources as the 241-U-361 tank. Because tank 270-W received supernatant discharged from the uranium trioxide process, the discharge is expected to contain little (if any) process solids. Therefore, the materials in tank 270-W are expected to contain significantly lower contaminant levels than the other three tanks.

9. Tanks 241-B-361, 241-T-361, and 241-U-361 can be located and accessed for sampling through the tank risers that have been blind-flanged and gasketed.

10. Tank 270-W is located under the 2715-UA Building floor and cannot be readily accessed; therefore, this tank will not be considered for verification sampling.

11. Based on current tank content information, direct sludge sampling would be a major effort due to access (i.e., the tanks are physically isolated), health and safety (e.g., exposure), and sample disposal issues.

12. Tank 241-U-361 has the largest inventory of sludge and comparably high relative risk rankings. This tank is also readily accessible for sampling and is recommended for verification sampling.

1.3 PROJECT ISSUES

1.3.1 Global Issues

No global issues have been identified for this project.

1.3.2 Task-Specific Technical Issues and Resolutions

The technical issues for this project primarily apply to tank sampling and the use of vapor results to assess the various risk/hazard classes. The tanks will be accessed through one or more of the flanged risers. Vapor samples will be collected through a variety of accepted standard methods or field screening methods using field instruments. Access to tank 270-W would require partial removal of the concrete slab that covers the tank and possible modifications to the building over the tank. Sampling of tank 270-W is not recommended.

1.4 EXISTING REFERENCES

Table 1-1 presents a list of all of the references that were reviewed as part of the scoping process, and a summary of the pertinent information contained within each reference. These references are the primary source for the background information presented in Section 1.5.

Table 1-1. Existing References. (2 Pages)

Reference	Summary
Environmental Restoration Contract (ERC) Management Plan for Inactive Miscellaneous Underground Storage Tanks (IMUSTs), BHI-01018, Rev. 1 (BHI 1999)	Contains a summary of IMUST status/background, best available content data, safety issues, and risk-ranking results.
Engineering Study of 50 Miscellaneous Inactive Underground Storage Tanks Located at the Hanford Site, Washington, WHC-SD-EN-ES-040, Rev. 0 (WHC 1994)	Contains a summary of tank status/background (including the four IMUSTs in the current study), evaluation of regulatory requirements, safety hazard assessment, discussion of monitoring/characterization needs, and risk prioritization.
An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks, WHC-SD-WM-ER-133 (WHC 1991)	Discusses process information for 200-TW-1 Operable Unit sites, including chemicals used and modeling of liquid effluents discharged to soil and kept in tanks. Contains the results of waste stream designation and modeled inventories for the cribs/trenches containing the scavenged uranium recovery process waste streams.
Hanford Tank Chemical and Radionuclide Inventories: HDW Model, Rev. 4, LA-UR-96-3860 (Agnew et al. 1997)	Discusses the scavenged and uranium recovery process waste and provides COC comparisons.
U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52 (DOE-RL 1992b)	Contains process information on U Plant facilities, the chemicals and radionuclides that were used and discharged, known and suspected contaminants, and a list of COPCs.
T Plant Source Aggregate Area Management Study Report, DOE/RL-91-61 (DOE-RL 1992a)	Contains waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste producing processes in T Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Discusses the process history of T Plant aggregate area, waste management operations history, chemical waste inventories estimates.

Table 1-1. Existing References. (2 Pages)

Reference	Summary
B Plant Source Aggregate Area Management Study Report, DOE/RL-92-05 (DOE-RL 1993)	Contains waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste producing processes in B Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Discusses the process history of B Plant aggregate area, waste management operations history, chemical waste inventories estimates, and history of unplanned releases.
Personal communication with N. R. Kerr (BHI) regarding criticality evaluation results for the four IMUSTs, July 2000	The BHI criticality safety specialist and nuclear design engineering specialist have reviewed the various waste sites of the Radiation Area Remedial Action Program. The review of 245 waste sites, which include the IMUST waste sites, concluded that no criticality safety limits and no criticality safety controls are required for the normal or abnormal conditions under the Radiation Area Remedial Action Program of surveillance, maintenance, and transition. The settling tanks, however, potentially contain sufficient amounts of fissionable material that planned changes require further criticality evaluation of activities that could change quantity, reflection, or distribution of significant quantities of fissionable material (e.g., sludge sampling or removal). Field verification requirements, defined in the criticality evaluation that are applicable to planned changes are controlled in the criticality safety evaluation (i.e., 0000X-CE-N0001 [BHI 2000a]). The criticality safety evaluations of the waste sites (e.g., 0000X-CE-N0001 [BHI 2000a], 0000X-CE-N0002 [BHI 2000b], 0000X-CE-N0003 [BHI 1998b], 0000X-CE-N0004 [BHI 1998a], and 0200E-CE-N0007 [BHI 1997]) are the used as the basis to dismiss accidental nuclear criticality hazards from the IMUSTs, as well as the other Radiation Area Remedial Action waste sites.

BHI = Bechtel Hanford, Inc.
COC = contaminant of concern

1.5 SITE BACKGROUND INFORMATION

For IMUST history and background information, refer to Sections 3.5, 3.6, 3.7, and 3.12 of the management plan for the IMUSTs (BHI 1999).

1.6 DATA QUALITY OBJECTIVE TEAM MEMBERS AND KEY DECISION MAKERS

Individual members of the DQO team were selected to participate in the seven-step DQO process based on their technical backgrounds. The DOE is the key decision maker and was involved in making final decisions regarding the sampling design.

Table 1-2. DQO Team Members.

Name	Organization	Role and Responsibility
Artemis Antipas	CH2M Hill Inc.	Facilitator, Report Author
Janet Badden	CHI	Regulatory Support
Grant Ceffalo	BHI	Radiological Control
Robert Egge	BHI	BHI Task Lead
Duane Jacques	CHI	CHI Task Lead
Noel Kerr	BHI	Hazard Classification, Nuclear Engineering
Mike Maxson	BHI	Process/Site History
Roger Ovink	CHI	Facilitator, Report Author
Cliff St. John	BHI	Health and Safety
Wendy Thompson	BHI	Sampling
John Wiles	BHI	Radiological Control
Rich Weiss	CHI	Chemistry, Analytical Methods
Michelle Yates	CHI	Process History

CHI = CH2M Hill Hanford, Inc.

Table 1-3. DQO Key Decision Makers.

Name	Organization	Role and Responsibility
John Sands	RL	RL Task Lead

1.7 PROJECT BUDGET AND CONTRACTUAL VEHICLES

Table 1-4 presents the budget for all of the task activities associated with development and implementation of the sampling program (i.e., laboratory analyses, data quality assessment, and reporting). For subcontracted activities, Table 1-4 presents the available contractual vehicles.

Table 1-4. Task Budget and Contractual Vehicles.

Task Activities	Budget	Contractual Vehicle
DQO workbook development	$43,062	--
Sampling and analysis plan development	$30,830	--
Field implementation	TBD (based on DQO results)	--
Laboratory analyses	TBD (based on DQO results)	--
Data quality assessment	N/A	--
Documentation of investigation results	TBD (based on DQO results)	--

N/A = not applicable
TBD = to be determined

1.8 MILESTONE DATES

Table 1-5 presents the milestone or project schedule dates for task completion. The IMUST Project does not have *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) milestones. The dates provided in the table are based on the project's schedule dates.

Table 1-5. Milestone Dates.

Task Activities	Milestone Date
DQO workbook development	August 31, 2000
Sampling and analysis plan development	September 28, 2000
Field implementation	FY 2001
Laboratory analyses	FY 2001
Data quality assessment	FY 2001
Documentation of investigation results	FY 2001

FY = fiscal year

1.9 CONTAMINANTS OF CONCERN

A list of the contaminants of concern (COCs) for the site under investigation was generated by initially listing all of the COPCs based on historical process operations. Certain COPCs were then removed from the list if they were being addressed under a separate sampling and analysis plan or a waste management plan. Certain COPCs were also removed if they have a short half-life, are not regulated, pose no risk, or are non-toxic, or if process knowledge/analytical data confirm that insignificant releases have occurred.

1.9.1 Total List of Contaminants of Potential Concern

Table 1-6 identifies all of the COPCs for each type of media expected in the tank. For this task, in addition to chemical or radiological constituents, the parameters of concern that need to be taken into consideration are hydrogen generation, ferrocyanide reactivity, organic salt reactivity, high heat, criticality, flammability, noxious vapor emissions, leak potential, and radiological hazards. These parameters need to be carried through the DQO process with the COPCs/COCs.

Table 1-6. Total List of COPCs for Each Media Type.

Media	Known or Suspected Source of Contamination	Type of Contamination (General)	COPCs [a] (Specific)
Tank sludge	221-B, 221-U, 221-T, 224-U process waste	Radionuclides	Pu-238, Pu-239/240, Sr-90, Ru-106, Cs-137, Co-60, U-235, U-238
		Metals/inorganics	Al, Fe, Ca, Ni, Si, Na, Mg, Mn, NO_2, NO_3, CO_3, PO_4, CN, pH, moisture (water)
		Organics	VOAs, TOC
Tank vapor	Tank sludge	Gases, organics	Hydrogen, VOCs

[a] See text for parameters of concern.
TOC = total organic carbon
VOA = volatile organic analyte
VOC = volatile organic compound

1.9.2 Contaminants of Potential Concern Addressed by Concurrent Remediation Activities

The scope of a DQO process in support of remediation activities typically assumes the responsibility for all media at the site. However, if certain media and associated COPCs are already being addressed by concurrent activities (i.e., under a separate sampling and analysis plan or waste management plan), the media/associated COPCs may be excluded from further consideration in this DQO process. Table 1-7 presents a list of the COPCs that are being removed from the total list of COPCs for this reason.

Table 1-7. COPCs Addressed by Concurrent Remediation Activities.

Media	COPCs	Remediation Activity
Not applicable.		

1.9.3 Other Contaminant of Potential Concern Exclusions

Table 1-8 presents a list of all other COPCs to be excluded from the investigation. These exclusions are in addition to the exclusions identified in Table 1-7 and are based on physical laws, process knowledge, task focus, or other mitigating factors.

Table 1-8. Rationale for COPC Exclusions.

Media	COPCs	Rationale for Exclusion
Sludge	Volatiles, organics	The 1999 study concluded levels of organic materials were not significant (BHI 1999).
	Cyanide	The 1991 study concluded that ferrocyanide/metal salt reaction is not expected because historical process data indicate that ferrocyanide was not part of the process waste that was directed to these four IMUSTs (WHC 1991).
	Pu-238, Pu-239/240, Sr-90, Ru-106, Cs-137, Co-60, U-235, U-238	Assessment of individual sludge components is not needed to verify the relative risk rankings of the IMUSTs.[a]
	Al, Fe, Ca, Ni, Si, Na, Mg, Mn, NO_2, NO_3, CO_3, PO_4, CN, pH, moisture (water)	Assessment of individual sludge components and characteristics is not needed to verify the relative risk rankings of the IMUSTs.

[a] Aside from risk, the other radiological aspect of the IMUSTs sampling is worker protection. Because radiological worker protection is an ERC Radiological Control organization function, it is covered by existing procedures and is not discussed further in this DQO process.

As discussed in Table 1-8, the concentrations of organic materials and chemical contaminants in the sludge, as well as the radioactive inventory were determined to be insignificant, or not needed to verify the relative risk rankings for the tanks in the IMUST management plan (BHI 1999). These statements indicate that the sludge is not a risk driver for the IMUSTs. However, the constituents in the sludge could generate heat, organic vapors, or hydrogen gas (by radiolytic decomposition) which could pose a risk. Therefore, the gasses and vapors in the tanks must be evaluated in this study.

1.9.4 Final List of Contaminants of Concern

Table 1-9 presents the final list of COCs for each media to be carried through the remainder of the DQO process.

Table 1-9. Final List of COCs.

Media	COCs
Vapor	Hydrogen, VOC

1.9.5 Distribution of Contaminants of Concern

Table 1-10 identifies the best understanding of how each of the COCs arrived at the site and the fate and transport mechanisms (e.g., wind or water) that may have impacted the distribution (e.g., layering or lateral homogeneity) of each of the COCs.

Table 1-10. Distribution of COCs.

Media	COCs	How COC Arrived at Site	Fate and Transport Mechanisms	Expected Distribution (Heterogeneous or Homogeneous)
Vapor	See Table 1-6	Tank sludge	Evaporative or diffusive transport from the parent sludge media to the tank air space. Leakage could lead to releases to vadose soils or atmosphere.	Homogeneous

1.10 CURRENT AND POTENTIAL FUTURE LAND USE

The current and potential future uses for the land in the immediate vicinity of the site under investigation are summarized in Table 1-11. This information is needed later in the DQO process to support the evaluation of decision error consequences.

Table 1-11. Current and Potential Future Land Use.

Current Land Use	Potential Future Land Use
DOE limited access	Industrial

1.11 PRELIMINARY ACTION LEVELS

The preliminary action levels that apply to each of the COCs are presented in Table 1-12 with the basis for each level. The action level is defined as the threshold value that provides the criterion for choosing between alternative actions (AAs). The action levels presented in Table 1-12 are based on the risk/hazard parameters identified in the IMUST management plan (BHI 1999). The listed parameters of concern constitute the basis of the DQO process.

Table 1-12. List of Preliminary Action Levels.

Media	COCs/Parameters of Concern	Preliminary Action Level	Basis
Free liquid	Leak potential	Detection of free liquids, visible detection of sludge surface characteristics, and tank condition	BHI 1999
Vapor	Hydrogen generation[a]	LEL concentrations of hydrogen	BHI 1999
	Flammability	LEL concentrations of flammable gases	
	Noxious vapor emissions	Presence of vapors, VOCs	
	Temperature	Elevated vapor temperatures	

[a] Radiolytic decomposition (as noted in BHI 1999).
LEL = lower explosive limit

1.12 CONCEPTUAL SITE MODEL

Sampling designs should confirm or reject the conceptual site model. The conceptual site model will be refined as additional data become available. Table 1-13 presents a tabular depiction of the IMUST conceptual site model. This table also summarizes the exposure scenarios.

Table 1-13. Tabular Depiction of the Conceptual Site Model.

Media	COCs	Source	Release Mechanism	Migration Pathways	Potential Receptors
Free liquids	N/A	Free liquid in tank	Liquid or vapor releases to vadose soils or the air.	Tanks to soil, soils to groundwater, and soils to air	Site workers, ecological receptors
Exposure Scenario: Workers handle soil/groundwater samples; inhale vapor.					
Vapor	See Table 1-6	Tank sludge	Evaporative or diffusive transport from the parent sludge media to the tank air space. Leakage could lead to releases to vadose soils or atmosphere.	Tanks to soil, and soils to air	Site workers. ecological receptors
Exposure Scenario: Workers handle soil samples; inhale vapor.					

N/A = not applicable

1.13 STATEMENT OF THE PROBLEM

The IMUST risk assessment/hazard basis update for tanks 241-B-361, 241-T-361, 241-U-361, and 270-W includes validation of the results of the last risk assessment/hazard basis that was performed (BHI 1999). In order to verify the risk assessment/hazard basis for the four identified IMUSTs, data from the vapor media in at least one IMUST is needed. The 241-U-361 tank has been selected for sampling because it has the largest sludge inventory and is considered to have a comparably high relative risk ranking of the IMUSTs managed by the ERC.

2.0 STEP 2 – IDENTIFY THE DECISION

In DQO Step 2, the principal study questions (PSQs) address the problem statement, the AAs that would result from the resolution of the PSQs, and the project decision statements (DSs). Table 2-1 presents the PSQs, AAs, and resulting DSs. The table also provides a qualitative assessment of the severity of the consequences of taking an incorrect AA. The basis for the PSQs and DSs for this project are the hazard classes defined in the management plan for the IMUSTs (BHI 1999).

Table 2-1. Summary of DQO Step 2 Information. (2 Pages)

PSQ-AA #	Alternative Action	Consequences of Implementing the Wrong Alternative Action	Severity of Consequences (Low/Moderate/Severe)
PSQ #1 – Do the IMUSTs represent a hydrogen generation risk?			
1a	Evaluate additional sampling and monitoring actions.	Evaluation of unnecessary sampling and monitoring actions.	Low
1b	Implement mitigating actions.	Implementation of unnecessary mitigating actions.	Low
1c	Maintain the current tank status.	Hydrogen generation could result in gas pressure buildup and possible ignition.	Severe
DS #1 – Determine if the IMUSTs represent a hydrogen generation risk, evaluate additional sampling and monitoring actions, or implement mitigating actions, or maintain the current tank status.			
PSQ #2 – Do the IMUSTs represent a heat generation risk?			
2a	Evaluate additional engineering and sampling/monitoring actions.	Evaluation of unnecessary engineering and sampling/monitoring actions.	Low
2b	Maintain the current tank status.	Heat generation could result in tank pressure increases and possible tank releases.	Moderate
DS #2 – Determine if the IMUSTs represent a heat generation risk, evaluate additional engineering and sampling/monitoring actions, or maintain the current tank status.			
PSQ #3 – Do the IMUSTs represent a flammability risk?			
3a	Evaluate additional sampling and monitoring actions.	Evaluation of unnecessary sampling and monitoring actions.	Low
3b	Implement mitigating actions.	Implementation of unnecessary mitigating actions.	Low
3c	Maintain the current tank status.	Flammability could result in a tank fire.	Severe
DS #3 – Determine if the IMUSTs represent a flammability risk, evaluate additional sampling and monitoring actions, or implement mitigating actions, or maintain the current tank status.			

Table 2-1. Summary of DQO Step 2 Information. (2 Pages)

PSQ-AA #	Alternative Action	Consequences of Implementing the Wrong Alternative Action	Severity of Consequences (Low/Moderate/Severe)
PSQ #4 – Do the IMUSTs represent a vapor emission risk?			
4a	Evaluate additional sampling and monitoring actions.	Evaluation of unnecessary sampling and monitoring actions.	Low
4b	Implement mitigating actions.	Implementation of unnecessary mitigating actions.	Low
4c	Maintain the current tank status.	Vapor emissions could result in an increased tank pressure and possible tank releases.	Moderate
DS #4 – Determine if the IMUSTs represent a vapor emission risk, evaluate additional sampling and monitoring actions, or implement mitigating actions, or maintain the current tank status.			
PSQ #5 – Do the IMUSTs represent a leak potential risk?			
5a	Evaluate alternative mitigating actions.	Evaluation of unnecessary mitigating actions.	Low
5b	Maintain the current tank status.	Leaks could result in tank contents entering the vadose soils, possible contaminating local groundwater.	Moderate
DS #5 – Determine if the IMUSTs represent a leak potential risk, evaluate alternative mitigating actions, or maintain the current tank status.			

3.0 STEP 3 – IDENTIFY INPUTS TO THE DECISION

In DQO Step 3, the type of data needed to resolve the DSs identified in DQO Step 2 are identified. The data may already exist, may be derived from computational methods, or may exist from surveying/sampling and analysis. Analytical performance requirements (e.g., practical quantitation limit [PQL] requirement, precision, and accuracy) are also provided in this step.

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-1 specifies the information (data) required to resolve the DSs identified in Table 2-1 and identifies if the data already exist. For existing data, the sources are provided with a qualitative assessment regarding their adequacy to resolve the DSs.

Table 3-1. Required Information and Reference Sources.

DS #	Variable of Interest	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality (Y/N)	More Data Needed? (Y/N)	Rationale
1	Hydrogen gas presence	Hydrogen gas levels and/or indicators	Y	BHI 1999	N	Y	--
2	Heat	Tank temperatures	N	BHI 1999	N	Y	--
3	Flammability	Flammability indicators	Y	BHI 1999	N	Y	--
4	Vapor emissions	Noxious vapor levels, noxious vapor indicators	Y	BHI 1999	N	Y	--
5	Leak potential	COC levels, soil moisture in soils around or under the tanks	N	BHI 1999	N/A	Y[a]	The tanks leaked while in use and are not expected to contain free liquids (this must be verified).

[a] The information need is limited to confirming the absence of free liquids and visual observation of the structural integrity of the tanks.
N/A = not applicable

3.2 DATA GAP SUMMARY

Data gaps exist for DS #1 through #5. Therefore, these decisions must be resolved by environmental measurements.

3.3 BASIS FOR SETTING THE ACTION LEVEL

The action level is the threshold value that provides the criterion for choosing between AAs. Table 3-2 identifies the numerical values for the action levels and the basis (i.e., regulatory threshold or risk-based) for each COC.

Table 3-2 shows two action levels for DS #1, #3, and #4, which provides a margin of safety in the decision-making process for those decisions. This approach has significance in the development of the decision rules (DRs) in DQO Step 5.

Table 3-2. Basis for Setting Action Level. (2 Pages)

DS #	Variable of Interest	COCs	Action Level	Basis for Setting Action Level[a]
Hydrogen Generation Risk				
1	Hydrogen concentration versus LEL	Hydrogen	10% of the LEL (4.1%)	Administrative margin of safety applied to the LEL for evaluation of mitigating alternatives.
			50% of the LEL (4.1%)	Administrative margin of safety applied to the LEL for implementation of mitigating alternatives.
Heat Generation Risk				
2	Measured temperature vs. ambient soil temperature	Temperature	10^{o}F greater than ambient soil temperature	Administrative margin of safety applied to the temperature for evaluation of mitigating alternatives.
Flammability Risk				
3	Measured hydrogen gas/ VOC concentration versus LEL	Hydrogen, VOC	10% of the hydrogen LEL or 25% of the limiting VOC LEL	Administrative margin of safety applied to the LEL for evaluation of mitigating alternatives.
			50% of the limiting LEL (hydrogen or VOC vapors)	Administrative margin of safety applied to the LEL for implementation of mitigating alternatives.

Table 3-2. Basis for Setting Action Level. (2 Pages)

DS #	Variable of Interest	COCs	Action Level	Basis for Setting Action Level[a]
Vapor Emission Risk				
4	Measured VOC concentration	VOC	150 ppm total VOC[b]	Administrative margin of safety applied to the VOC for evaluation of mitigating alternatives.
			300 ppm total VOC[b]	Administrative margin of safety applied to the VOC for implementation of mitigating alternatives.
Leak Potential				
5	Leak potential	Visual observation	Visual indications of free liquids within tanks, and/or cracking, spalling, or unusual surface conditions	Visual indication of free liquids and/or tank wall integrity.

[a] The administrative action levels are conservative values that were chosen by the DQO team to provide safety margins for evaluation and implementation of mitigating actions before tank conditions reach critical vapor concentrations or temperatures.
[b] The administrative action levels for VOC are based on worker protection limits for methyl ethyl ketone (MEK). MEK is the most restrictive VOC detected in 221-U sludge samples.
ppm = parts per million

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-3 identifies instances where existing data do not exist or are insufficient to resolve the DSs. For these DSs, Table 3-3 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-3. Information Required to Resolve the Decision Statements.

DS #	Variable of Interest	Required Data	Computational Methods	Survey/Analytical Methods
1	Hydrogen	Hydrogen	N/A	Light gas detection
2	Heat	Temperature	N/A	Thermocouple
3	Flammability	Hydrogen, VOC	N/A	Light gas/VOC detection
4	Vapor emissions	VOC	N/A	VOC detection
5	Leak potential	Visual observation	N/A	Video camera

N/A = not applicable

Table 3-4 presents details on the computational methods that were identified in Table 3-3.

Table 3-4. Details on Identified Computational Methods.

DS #	Computational Method	Source/Author	Application to Study
Not applicable.			

Table 3-5 identifies the survey and/or analytical methods that could provide the required information needed to resolve the DSs.

Table 3-5. Potentially Appropriate Survey/Analytical Methods.

DS #	Variable of Interest	Potentially Appropriate Survey/Analytical Method	Possible Limitations	Cost
1	Hydrogen	Summa canister sample, field instruments	Tank access	Medium
2	Heat	Field thermocouple	Tank access; ambient air temperature interference	Low
3	Flammability	Summa canister sample, field instruments	Tank access	Medium
4	Vapor emissions	Summa canister sample, field instruments	Tank access	Medium
5	Leak potential	Video camera	Tank access; visual observation may not an absolute method of determining tank wall integrity	Low

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Table 3-6 lists the analytical performance requirements for the data needed to resolve the DSs. These performance requirements include the PQL and the precision and accuracy requirements for each COC.

Table 3-6. Analytical Performance Requirements.

Data Type	**Analytical Method**	**Analyte**	**Preliminary Action Level**	**Practical Quantitation Limits**	**Accuracy Req't (% Recovery)[b]**	**Precision Req't (%RSD or RSD)**
Hydrogen	Hydrogen from summa	Hydrogen	10% LEL (0.41%)	0.5%	70-130	±30
Temperature	Thermocouple	Temperature	>10°F above ambient soil	N/A	N/A	±1°F
Flammability	Field instrument	LEL	10% LEL	Meter-specific[a]	70-130	±30
		Total VOC	150 ppm, total VOC	Meter-specific[b]	70-130	±30
Vapor emissions	VOA from summa (EPA TO-14)	VOC	Presence of VOC	<1 ppb (chlorinated hydrocarbons) 10 ppb (oxygenated organics)	c	c

[a] The PQL for flammability will be meter- and calibration-specific. Meters are typically calibrated for methane.
[b] The PQL for total VOC will be meter- and calibration-specific. Meters are typically calibrated for isobutylene.
[c] Requirements as specified by the referenced method.
MDL = minimum detectable level
N/A = not applicable
ppb = parts per billion
RSD = relative standard deviation

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

In DQO Step 4, the population of interest, the spatial and temporal boundaries that apply to each DS, the scale of decision making, and any practical constraints (i.e., hindrances or obstacles) that must be taken into consideration in the sampling design are defined.

4.1 POPULATION OF INTEREST

Prior to defining the spatial and temporal boundaries of the site under investigation, it is first necessary to clearly define the populations of interest that apply for each DS (Table 4-1). The intent of Table 4-1 is to clearly define the attributes that make up each population of interest by stating them in a way that makes the focus of the study unambiguous.

Table 4-1. Characteristics that Define the Population of Interest.

DS #	Population of Interest	Characteristics
1	Air space in the IMUSTs	Tank hydrogen content
2	Air space in the IMUSTs	Tank ambient air temperature
3	Air space in the IMUSTs	Individual tank vapor and hydrogen concentrations
4	Air space in the IMUSTs	Individual tank vapor VOC concentration
5	Tank free liquids	Observable free liquids in tanks
	Tank wall conditions	Physical condition of tank walls

4.2 GEOGRAPHIC BOUNDARIES

Table 4-2 identifies the geographic boundaries that apply to each DS. Limiting the geographic boundaries of the study area ensures that the investigation does not expand beyond the original scope of the task.

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
1 through 5	The individual tanks.

4.3 ZONES WITH HOMOGENEOUS CHARACTERISTICS

Table 4-3 defines the zones within the tanks that have homogeneous characteristics. These zones were identified by using existing information to segregate the elements of the population into subsets that exhibit relatively homogeneous characteristics (e.g., types of contaminants).

Table 4-3. Zones with Homogeneous Characteristics.

DS #	Population of Interest	Zone	Homogeneous Characteristic Logic
1, 3, and 4	Air space in IMUSTs	Air space	Potential presence of hydrogen and VOCs in tank air space.
2	Air space in the IMUSTs	Air space	Potential heat generation from tank sludge.
5	Tank free liquids	Liquids in tank above sludge layer	Free liquids in the tank above the sludge layer with potential to leak.
	Tank wall conditions	Tank walls	Tank wall surfaces that may have corroded and degraded tank integrity.

4.4 TEMPORAL BOUNDARIES

Table 4-4 identifies temporal boundaries that may apply to each DS. The temporal boundary refers to both the timeframe over which each DS applies (e.g., number of years) and when (e.g., season) the data should be collected.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
1 through 5	Annual monitoring	No restrictions

4.5 SCALE OF DECISION MAKING

In Table 4-5, the scale of decision making has been defined for each DS. The scale of decision making is defined by joining the population of interest and the geographic and temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Scale of Decision
			Time-frame	When to Collect Data	
1, 3, and 4	Air space in the IMUSTs	Individual tanks	Annual	No restrictions	The tank air space
2	Tank temperature	Individual tanks	Annual	No restrictions	Tank air space
5	Tank free liquids	Individual tanks	Annual	No restrictions	Liquids in tank above sludge layer
	Tank wall integrity	Individual tanks	Annual	No restrictions	Tank walls

4.6 PRACTICAL CONSTRAINTS

Table 4-6 identifies the practical constraints that may impact the data collection effort. These constraints include physical barriers, difficult sample matrices, high radiation areas, or any other condition that will need to be taken into consideration in the design and scheduling of the sampling program.

Table 4-6. Practical Constraints for Data Collection.

- Limited tank access to collect samples (e.g., from flanged/gasketed risers and the building/cement slab over tank 270-W).
- Worker safety considerations during sampling.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of DQO Step 5 is initially to define the statistical parameter of interest (i.e., mean or 95% upper confidence level [UCL]) that will be used for comparison with the action level. The statistical parameter of interest specifies the characteristic or attribute that the decision-maker would like to know about the population. The final action level for each of the COCs is also identified in DQO Step 5. When this is established, a DR is developed for each DS in the form of an "IF…THEN…" statement that incorporates the parameter of interest, the scale of decision making, the action level, and the AAs that would result from resolution of the decision. Note that the scale of decision making and AAs were identified earlier in DQO Steps 4 and 2, respectively.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1 and 5-2 present the information needed to formulate the DRs identified in Section 5.2. This information includes the DSs and AAs identified earlier in DQO Step 2, the scale of decision making identified in Step 4, the statistical parameter of interest, and the final action levels for each of the COCs.

Table 5-1. Decision Statements

DS #	Decision Statement
1	Determine if the IMUSTs represent a hydrogen generation risk, evaluate additional sampling and monitoring actions, implement mitigating actions, or maintain the current tank status.
2	Determine if the IMUSTs represent a heat generation risk, evaluate additional engineering and sampling/monitoring actions, or maintain the current tank status.
3	Determine if the IMUSTs represent a flammability risk, evaluate additional sampling and monitoring actions, implement mitigating actions, or maintain the current tank status.
4	Determine if the IMUSTs represent a vapor emission risk, evaluate additional sampling and monitoring actions, implement mitigating actions, or maintain the current tank status.
5	Determine if the IMUSTs represent a leak potential risk, evaluate alternative mitigating actions, or maintain the current tank status.

Table 5-2. Inputs Needed to Develop Decision Rules. (2 Pages)

DS #	COCs/ Parameters of Concern	Statistic of Interest	Scale of Decision Making	Final Action Level	Alternative Actions
1	Hydrogen generation	95% UCL of the mean	Tank air space	>10% LEL	Evaluate additional sampling and monitoring actions.
				>50% LEL	Implement mitigating actions.
				<10% LEL	Maintain the current tank status.
2	Surface sludge and vapor temperature	Maximum detected	All tank contents	>10°F difference between tank temperature and ambient soil temperature	Evaluate additional engineering and sampling/monitoring actions.
				<10°F difference	Maintain the current tank status.
3	Flammability	95% UCL of the mean	Tank air space	>10% of the hydrogen LEL or 25% of the limiting VOC LEL	Evaluate additional sampling and monitoring actions.
				>50% of the limiting LEL (hydrogen or VOCs)	Implement mitigating actions.
				<10% of the hydrogen LEL or 25% of the limiting VOC LEL	Maintain the current tank status.
4	Noxious vapor emissions	Maximum detected value	Tank air space	>150 ppm total VOC	Evaluate additional sampling and monitoring actions.
				>300 ppm total VOC	Implement mitigating actions.
				<150 ppm total VOC	Maintain the current tank status.

Table 5-2. Inputs Needed to Develop Decision Rules. (2 Pages)

DS #	COCs/ Parameters of Concern	Statistic of Interest	Scale of Decision Making	Final Action Level	Alternative Actions
5	Leakage potential	N/A	Liquids above sludge layer and tank walls	Presence of free liquids and/or degraded tank walls	Evaluate alternative mitigating actions.
				Absence of free liquids or degraded tank walls	Maintain the current tank status.

N/A = not applicable

5.2 DECISION RULES

Table 5-3 presents the DRs that correspond to each of the DSs from Table 5-1.

Table 5-3. Decision Rules. (2 Pages)

DS #	DR #	Decision Rule
1	1a	If the true mean (as estimated by the 95% UCL on the sample mean) concentration of hydrogen gas within the IMUSTs exceeds 10% of the LEL (4.1%), then evaluate additional sampling and monitoring actions; otherwise maintain the current tank status.
1	1b	If the true mean (as estimated by the 95% UCL on the sample mean) concentration of hydrogen gas within the IMUSTs reaches 50% of the LEL (4.1%), then implement mitigating actions.
2	2	If the maximum detected temperature of the IMUST sludge surface or tank vapors exceeds 10°F above the ambient soil temperature, then evaluate additional engineering and sampling/monitoring actions; otherwise maintain the current tank status.
3	3a	If the true mean (as estimated by the 95% UCL on the sample mean) concentration of hydrogen gas and/or VOCs within the IMUSTs reaches 10% of the hydrogen LEL or 25% of the limiting VOC LEL, then evaluate additional sampling and monitoring actions; otherwise maintain the current tank status.
3	3b	If the true mean (as estimated by the 95% UCL on the sample mean) concentration of hydrogen gas and/or VOCs within the IMUSTs reaches 50% of the hydrogen LEL or the limiting VOC LEL, then implement mitigating actions.
4	4a	If the maximum detected concentration of total VOCs (used as indicator for noxious gases) within the IMUSTs reaches 150 ppm, then evaluate additional sampling and monitoring actions; otherwise maintain the current tank status.

Table 5-3. Decision Rules. (2 Pages)

DS #	DR #	Decision Rule
4	4b	If the maximum detected concentration of total VOCs (used as indicator for noxious gases) within the IMUSTs reaches 300 ppm, then implement mitigating actions.
5	5	If visual inspection reveals the presence of free liquids or degradation of the tank walls, evaluate alternative mitigating actions; otherwise maintain current tank status.

It should be noted that DRs #1, #3, and #4 have "a" and "b" parts that make distinctions in action levels and AAs. In each case, the "a" DR applies a conservative administrative action level that is used by the project team to trigger engineering evaluation of possible AAs while lead time is available. The "b" DRs apply different administrative action levels to signal the need for implementation of the mitigating actions before critical conditions are reached. The administrative action levels are presented in Table 3-2.

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data can only estimate the true condition of the site under investigation, decisions that are made based on measurement data could potentially be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which DSs (if any) require statistically based sample designs. For those DSs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a non-statistical sampling design for each DS. The factors that were taken into consideration in making this selection included the timeframe over which each of the DSs applies, the qualitative consequences of an inadequate sampling design, and the accessibility of the site if resampling is required.

Table 6-1. Statistical Versus Non-Statistical Sampling Design.

DS #	Timeframe	Qualitative Consequences of Inadequate Sampling Design (Low/Moderate/Severe)	Resampling Access After Remediation (Accessible/Inaccessible)	Proposed Sampling Design (Statistical/ Non-Statistical)
1	1 year	Severe	Accessible	Non-statistical
2		Moderate		Non-statistical
3		Severe		Non-statistical
4		Moderate		Non-statistical
5		Low		N/A

N/A = not applicable

6.2 NON-STATISTICAL DESIGNS

For the DSs to be resolved using a non-statistical design, there is no need to define the "gray region" or the tolerable limits on decision error because these only apply to statistical designs. Refer to Section 7.1 for details on the non-statistical sampling designs.

Due to physical tank access constraints, non-statistical sampling of the tanks is being proposed for this round of monitoring. If data are found to indicate levels of concern for any of the DSs, further evaluations for statistical sampling will be considered.

6.3 STATISTICAL DESIGNS

An initial step in the process of establishing a statistically based sample design to define the expected range of the statistical parameter of interest (i.e., mean or 95% UCL) for each COC. Table 6-2 defines the expected statistical parameter of interest concentration ranges for each COC based on the evaluation of historical analytical data.

Table 6-2. Statistical Parameter of Interest Concentration Ranges.

DS #	Media	COCs	Statistical Parameter of Interest	Range	
				Lower Limit	Upper Limit
Not applicable.					

6.4 DECISION ERRORS

The two types of decision error that could occur are as follows: treating (i.e., managing and disposing) clean site media as if it were contaminated, and treating (i.e., managing and disposing) contaminated site media as if it were clean. The decision error that has the more severe consequence is the latter because the error could result in human health and/or ecological impacts.

6.5 NULL HYPOTHESIS

Table 6-3 identifies the null hypothesis that applies to the site under investigation. The term "null hypothesis" refers to the baseline condition of the site, which has been defined based on the historical data and process knowledge identified in the scoping summary report. The null hypothesis states the opposite of what is hoped to be demonstrated.

Table 6-3. Defining the Null Hypothesis.

Null Hypothesis Statement	Indicate Selection
Tank media are assumed to exceed the current risk basis/hazard assessment until shown not to exceed.	N/A
Tank media are not to exceed the current risk basis/hazard assessment until shown to exceed.	N/A

N/A = not applicable

6.6 TOLERABLE LIMITS FOR DECISION ERROR

For each DS, Tables 6-4 and 6-5 present the selected statistical design to be implemented (i.e., simple random or random systematic), the boundaries of the gray region, and the probability values to points above and below the gray region that reflect the decision makers' tolerable limits for making an incorrect decision.

Table 6-4. Statistical Designs.

DS #	Media	Selected Statistical Design	Boundaries of the Gray Region	Tolerable Limits for Incorrect Decision	
				At Lower Bound of Gray Region	At Action Level
Not applicable.					

Table 6-5. Tolerable Decision Errors.

DS #	Media	COCs	Statistical Parameter of Interest	Statistical Parameter of Interest Range	Final Action Level	Gray Region	Tolerable Decision Error	
							At Lower Bound of Gray Region (%)	At Action Level (%)
Not applicable.								

7.0 STEP 7 – OPTIMIZE THE DESIGN

The objective of DQO Step 7 is to present alternative data collection designs that meet the minimum data quality requirements specified in DQO Steps 1 through 6. A selection process is then used to identify the most resource-effective data collection design that satisfies all of the data quality requirements. Table 6-3 differentiates between those DSs that require a statistical sampling design from those that may be resolved using a non-statistical design.

7.1 NON-STATISTICAL DESIGN

Tables 7-1 through 7-3 have been completed for those DSs to be resolved using a non-statistical approach.

7.1.1 Non-Statistical Screening Method Alternatives

Table 7-1 identifies the screening technologies that were considered to resolve each DS and the optional methods of implementing each technology. The table also summarizes the limitations associated with each screening technology and/or method of implementation and provides an estimated cost for implementation.

Table 7-1. Potential Non-Statistical Screening Alternatives.

DS #	Media	Screening Technology	Potential Implementation Designs	Limitations	Cost
1, 3, and 4	Tank vapor	Portable field meter	Readings from the 10.2-cm (4-in.) vent riser	Tank access, ambient air influences, meters are not analyte-specific.	
2	Tank vapor and sludge surface	Thermocouple	Readings for sludge surface and vapor from the 10.2-cm (4-in.) vent riser	Sludge readings limited to surface measurements.	Low
5	Tank free liquids and tank walls	Video camera	Visual survey of tank interior and sludge surface	Visual observation is not an absolute determination of tank conditions.	

7.1.2 Non-Statistical Sampling Method Alternatives

Table 7-2 identifies the various types of media that need to be sampled to resolve each DS and alternative methods for collecting the samples. This table presents alternative implementation designs for each sampling method and identifies any limitations that may be associated with each sampling method and/or design. An estimated cost for the implementation of each sampling design has also been provided for comparison purposes.

Table 7-2. Potential Non-Statistical Sampling Method Alternatives.

DS #	Media	Sampling Method	Potential Implementation Designs	Limitations	Cost
1, 3, and 4	Tank vapor	Vapor collection (summa canister) through risers	Two vapor samples through the 10.2-cm (4-in.) vent riser to be spread uniformly from the middle and bottom of the tank headspace.	Health and safety concerns, access for sampling device through riser, waste management issues, and ambient air influence on tank vapor collection (dilution problems).	High

7.1.3 Non-Statistical Implementation Design

This section presents the selected screening technologies and sampling methods for resolving each DS and a summary of the proposed implementation design. The table also provides the basis for the selected implementation design.

Table 7-3. Selected Implementation Design.

DS #	Media	Selected Screening Technologies	Selected Sampling Methods	Potential Implementation Designs
1, 3, and 4	Tank vapor	Field screening for total VOC, and LEL	Summa canister samples for hydrogen, VOC, and light gases	Vapor sample collection and field meter readings through the 10.2-cm (4-in.) vent riser.
5	Tank free liquids and tank walls	Video camera	Visual survey of tank interior	Visual observation is not an absolute determination of tank wall conditions.
Selected Implementation Design: Non-statistical.				
Basis for Selection: Available information, tank accessibility, and cost.				
2	Tank sludge	Thermocouple for temperature	None	Headspace and surface sludge temperature measurements through the 10.2-cm (4-in.) vent riser. A thermocouple will be lowered near the sludge surface for temperature measurement.
Selected Implementation Design: Non-statistical.				
Basis for Selection: Tank accessibility and cost.				

7.2 STATISTICAL DESIGN

Tables 7-4 through 7-8 are used for DSs requiring a statistical approach. The tables document the statistical tests selected for testing the null hypothesis, the formulas for calculating sample numbers, the number of samples required, the estimated cost for Type I (alpha) and Type II (beta) error tolerances, the results of the trade-off analysis, and a summary of the selected statistical design.

7.2.1 Data Collection Design Alternatives

Table 7-4 identifies the statistical design alternatives (i.e., simple random, stratified random, and systematic) that were evaluated for each DS, as well as the selected design and the basis for the selection.

Table 7-4. Selected Statistical Design.

DS #	Media	Statistical Design Alternatives
Not applicable.		

7.2.2 Mathematical Expressions for Solving Design Problems

Table 7-5 identifies the statistical hypothesis test (e.g., Wilcoxon Signed Rank Test or One Sample t-Test) that has been selected for testing the null hypothesis. The table presents the assumptions that were made about the population distribution (i.e., symmetrical or normal) in the selection process, as well as the formula for calculating the required number of samples.

Table 7-5. Statistical Methods for Testing the Null Hypothesis.

DS #	Media	Statistical Method Alternatives	Selected Statistical Method for Testing Null Hypothesis	Assumptions Made in Selecting Statistical Method	Formula for Calculating Number of Samples/ Measurements
Not applicable.					

7.2.3 Select the Optimal Sample/Measurement Size that Satisfies the Data Quality Objectives

Table 7-6 presents the total number of samples/measurements required to be collected for each DS with varying error tolerances and varying widths of the gray region. The total number of samples/measurements was calculated using the statistical method identified in Table 7-4. As would be expected, the higher the error tolerances and wider the gray region, the smaller the number of samples/measurements that are required.

Table 7-6. Sample/Measurement Size Based on Varying Error Tolerances and LBGR.

		Mistakenly Concluding < Action Level		
		α =	α =	α =
DS # = N/A				
LBGR = N/A				
Mistakenly Concluding > Action Level	β=			
	β=			
	β=			

LBGR = lower bound of gray region
N/A = not applicable

7.2.4 Sampling/Measurement Cost

For varying error tolerances, and varying widths of the gray region, Table 7-7 presents the total cost for sampling and analyzing the number of samples identified in Table 7-6. As would be expected, the higher the error tolerances, the wider the gray region, and the lower the sampling and analysis costs.

Table 7-7. Sampling Cost Based on Varying Error Tolerances and LBGR.

		Mistakenly Concluding < Action Level		
		α =	α =	α =
DS # = N/A				
LBGR = N/A				
Mistakenly Concluding > Action Level	β=			
	β=			
	β=			

N/A = not applicable

7.2.5 Selecting the Most Resource-Effective Data Collection Design

A trade-off analysis was performed to identify the most resource-effective number of samples/measurements for the given budget. It is important to consider trade-offs so contingency plans can be developed and the added value of selecting one set of considerations over another can be quantified. Table 7-8 identifies the sampling/measurement design that provides the best balance between cost and the ability to meet the DQOs.

Table 7-8. Most Resource-Effective Data Collection Design.

Field measurement techniques were selected for all the DSs requiring additional data (DS #1, #2, #3, #4, and #5). This decision is based on the implementation issues and relatively high costs associated with sampling the tank contents (i.e., vapor and/or sludge). The field techniques selected will adequately address the DQOs required to support tank risk assessment/hazard decisions.

7.3 FINAL SAMPLING DESIGN

For each DS, Table 7-9 presents a summary of the final non-statistical sampling design, identifying the total number of samples/measurements to be collected.

The data acquisition strategy for the tanks is to evaluate tank 241-U-361 based on inventory and process knowledge suggesting that this tank represents a comparably high potential hazard (based on the four IMUSTs under consideration). The measurements for tank 241-U-361 are expected to be conservative indicators for the other tanks regarding past operations and inventory (BHI 1999). If the results for tank 241-U-361 agree with the risk assessment/hazard determinations presented in BHI (1999), then additional data from tanks 241-B-361, 241-T-361, and 270-W will not be required. However, if the results for tank 241-U-361 do not support the risk assessment/hazard determinations presented in BHI (1999), then additional data will be collected from tank 241-B-361. Tank 214-B-361 is considered analogous to tank 241-T-361 in its use and the types of waste received. It the results for tank 241-B-361 do not agree with the risk assessment/hazard determinations presented in BHI (1999), then the need for additional data from tank 241-T-361 will be evaluated. Sampling tank 270-W is not recommended because it is located under the foundation of the 1715-UA Building.

Table 7-9. Final Sampling/Measurement Design.

DS #	Sampling/Measurement Design	Number of Samples/Measurements
1, 3, and 4	Tank vapor: Summa canister samples for hydrogen, VOC, and light gases. Samples and field measurements will be obtained from the 10.2-cm (4-in.) vent riser. Two data points/samples will be obtained from the riser at different elevations in the tank headspace.	Two samples and sets of readings from the 10.2-cm (4-in.) vent riser.
5	Remote video camera.	Visual survey of tank interior.
2	Tank vapor and surface of sludge: Thermocouple for temperature.	Temperature readings from the 10.2-cm (4-in.) vent riser.

8.0 REFERENCES

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