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Rev. 0

Data Quality Objective for 276-S-141/142 Hexone Tank Characterization/ Stabilization Project

Prepared for the U.S. Department of Energy, Richland Operations Office
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Data Quality Objective for 276-S-141/142 Hexone Tank Characterization/ Stabilization Project

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ACRONYMS

AA	alternative action
BHI	Bechtel Hanford, Inc.
CFR	*Code of Federal Regulations*
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
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
FY	fiscal year
NaI	sodium iodide
NOC	Notice of Correction
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
PSQ	principal study question
REDOX	Reduction-Oxidation (Plant/Facility)
RESRAD	RESidual RADioactivity dose model
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
S/M&T	Surveillance, Maintenance, and Transition
TCLP	toxicity characteristic leachate procedure
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic (waste)
TSD	treatment, storage, and disposal
UCL	upper confidence level
WAC	*Washington Administrative Code*

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METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

1.0 STEP 1 – STATE THE PROBLEM

The objective of data quality objective (DQO) Step 1 is to use the information gathered from the DQO scoping process, as well as other relevant information, to clearly and concisely state the problem to be resolved.

The 276-S-141/142 hexone storage tanks are two 89,000-L (23,575-gal) carbon-steel underground storage tanks located near the Reduction-Oxidation (REDOX) Facility on the Hanford Site. The tanks contain residual process materials (i.e., sludge) estimated at up to 950 L (250 gal) in each tank. The 276-S-141/142 storage tanks are managed as a treatment, storage, and disposal (TSD) facility (Permit #WA7890008967) and are regulated by the Washington State Department of Ecology (Ecology). In May 2000, Ecology issued a *Notice of Correction for Stabilization of the Hexone Storage and Treatment Facility, BHI Docket Number 00NWPKM006*, citing several findings concerning operation of the tank system.

The purpose of this DQO process is to develop a sampling and analysis strategy responsive to the waste verification and designation issues cited in the Notice of Correction (NOC) issued by Ecology. In addition, the sampling and analysis strategy will provide data to support an engineering study to evaluate interim actions concerning the tank facility.

1.1 PROJECT OBJECTIVES

- Collect and analyze tank waste residues in order to designate the materials in accordance with *Washington Administrative Code* (WAC) 173-303 requirements.
- Collect and characterize tank waste residues to provide data to support an engineering evaluation of the hexone tanks during fiscal year (FY) 2001.
- Collect and characterize tank waste residues to provide sufficient data to support interim tank actions as determined by the engineering study.

1.2 PROJECT ASSUMPTIONS

1. The tank residue contains an organic, tar-like component that may be difficult to sample and analyze (based on historical records and operator discussions).
2. The TSD permit application and facility closure plan include a contaminant list that will be used as a starting point for the contaminant of potential concern (COPC) list for this project.
3. The tank residue may contain a liquid component (i.e., hexone and/or water).
4. The tank wall integrity is suspect based on corrosion materials noted in the waste materials when the tanks were emptied and during distillation of the tank contents.

5. Worker health and safety will be a major concern during tank content sampling due to hexone vapors and potential flammability, which will be addressed in pre-job planning documents.

6. Access to the tanks for photographs/videotape and sampling can be achieved through the risers (4-in. diameter) and/or the manholes (24-in. diameter).

7. The tank residue data will support tank waste designation decisions.

8. The tank characterization data (residue and tank wall status) will support engineering study needs.

9. Data will be collected to determine a bounding estimate of the tank waste volume.

10. This characterization effort will only address residual materials inside the tanks. No materials (i.e., surface or vadose soils) outside the tanks will be sampled or analyzed.

1.3 PROJECT ISSUES

1.3.1 Global Issues

No global issues were identified for the Hexone Tank Contents Characterization/Stabilization Project.

1.3.2 Task-Specific Technical Issues and Resolutions

1. Worker health and safety concerns and physical access to the tanks represent significant limitations and must be addressed in the sample design.

   Health and safety concerns for the tanks are relatively well established (USQ Safety Evaluation Questions, REDOX Hexone Tanks, 0200W-US-N0144-02, Rev.1 [BHI 2000b]). Workers will be required to wear proper personal protective equipment for the hazards anticipated during sampling events. All equipment and devices used during the tank investigation must be suitable for a potentially flammable environment in the tanks (i.e., grounding and non-sparking tools).

   Access to the tanks will be through the tank risers (4-in.) or manholes (24-in.). Vapor sampling equipment currently present in the tanks will need to be removed to allow free access for the sampling effort. Due to potential tank corrosion, the allowable weight of equipment on the empty tanks must be seriously considered in the sampling design.

2. The residue in the tanks contains a tar-like organic component that may be difficult to sample due to the nature of the material.

The key to identifying an appropriate sampling technique is obtaining photos or video of the insides of the tanks. Cameras are available that could be lowered through the risers or manholes and may provide visual information on the composition (e.g., single-phase or multi-phase), volume, and distribution of the residual materials. If possible, the residue should be "probed" during the filming/photography to help determine physical characteristics of the material. Team discussions with Environmental Restoration Contractor (ERC) sampling specialists, tank farm samplers, and AEA (a Hanford subcontractor) have been initiated to identify devices that could successfully video and sample the tank contents.

3. The tank residue material contains a tar-like organic component that may be difficult to analyze by a laboratory.

   The analytical approach for the tank residue will be contingent upon the physical characteristics of the sample matrix. The material could be analyzed in bulk (i.e., homogenized), or the separate components (i.e., solids and liquids) could be individually analyzed. Organic solids would likely be dissolved in methylene chloride before analysis. Due to the nature of the tank waste, "masking" or "matrix" effects are expected, but these effects should not influence waste designation decisions.

4. A reasonable estimate of the tank residue volume is needed for the engineering study and for assessing potential interim closure options.

   The key to identifying an appropriate volume estimating technique is obtaining photos or video of the insides of the tanks. Cameras are available that could be lowered through the risers or manholes that may provide an estimate of the volume of the residue material based on the visual "footprint" of the material in the tanks. Limited tank access (i.e., only one riser and one manhole per tank) and variable distribution of the waste materials could compromise the accuracy of the volume calculations.

5. The COPC list is suspect due to incomplete process history information and chemical reactions that may have occurred in the tanks.

   The COPC list presented in the Part A Permit (#W7690008967) for the hexone tanks is a suitable preliminary list. A primary emphasis of this study will be to verify the conceptual model and to provide a comprehensive analysis of the COPCs.

6. Agreement on the tank waste designation (e.g., hazardous or dangerous) is a key component in successfully completing the engineering study and assessing potential interim closure options.

   The designation established for the tank wastes will drive the engineering study and will influence the interim closure options available for the tanks. Data collected must be suitable to designate the tank wastes, support tank waste treatment/disposal decisions, and support interim tank closure decisions.

1.4 EXISTING REFERENCES

Table 1-1 presents 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.

Reference	Summary
The Distillation and Incineration of 132,000 Liters of Mixed Waste Solvents from Hanford's REDOX Plant, WHC-EP-0570, Rev. 0 (WHC 1992)	Summary of equipment and processes used to remove, distill, and dispose of pumpable organic liquids from the 276-S-141/142 hexone storage tanks.
Hexone Storage and Treatment Facility Closure Plan, DOE/RL-92-40, Rev. 0 (DOE-RL 1992).	This document presents background information about the hexone tanks and describes the proposed closure plan for the tanks.
Notice of Correction for Stabilization of the Hexone Storage and Treatment Facility, CCN 079387, letter from R. Wilson/Ecology to K. Klein/RL and M. Hughes/BHI, dated May 26, 2000 (Ecology 2000)	This Ecology letter documents alleged non-compliance with the hexone tank closure plan and presents the steps and schedule required to complete the hexone tank stabilization task.
Baseline Change Proposal to perform Data Quality Objectives for the 276-S-141/142 Tanks to Support an Interim Remedy for Hexone Vapor Build-Up, BCP-20223, Rev. 0, dated May 24, 2000 (BHI 2000a)	BCP for the completion of the Hexone Tank Contents Characterization/Stabilization Project.
USQ Safety Evaluation Questions, REDOX Hexone Tanks, 0200W-US-N0144-02, Rev. 1, dated April 6, 2000 (BHI 2000b)	Evaluates worker health and safety issues for the 276-S-141/142 hexone tanks.

1.5 SITE BACKGROUND INFORMATION

The 276-S-141/142 hexone storage tanks are two carbon-steel, 89,000-L (23,575-gal) underground storage tanks. The tanks are located in the south-central portion of the Hanford Site's 200 West Area, on the 200 Areas Central Plateau. The tanks were constructed in 1951 and were used to store commercial-grade hexone for use in the plutonium and uranium extraction process until 1967. The tanks subsequently were used to store radioactively contaminated liquids from the REDOX Plant and possibly the Hot Semiworks facilities. Monitoring of steady liquid levels in the underground storage tanks (before the contents were removed for distillation) indicated low probability of leakage, although preliminary observations of the interior sludge revealed the presence of tank corrosion products.

Tank 276-S-141 held 75,700 L (20,000 gal) of essentially pure liquid hexone, contaminated with small amounts of fission products (0.0004 curie). Tank 276-S-142 contained substantially more fission products (0.12 curie). The two tanks also held a combined total of 0.7 curie of tritium.

In 1991, pumpable liquids were reported as removed from the tanks, distilled, and disposed. After removal and distillation of the liquid tank contents, the tanks each held up to 950 L (250 gal) of residual organic radioactive material. The tank system was then permitted with Ecology as an active TSD facility, and a closure plan was prepared.

To mitigate the presence of potentially flammable vapors, a nitrogen-gas blanket is maintained on the tank system. Recent sampling of the tank vapor indicates the nitrogen blanket is effective in mitigating the potentially flammable atmosphere in the tanks. In addition, potential ignition sources are prohibited from the facility.

1.6 DATA QUALITY OBJECTIVE TEAM MEMBERS AND KEY DECISION MAKERS

The members of the DQO team were selected to participate in the process based on their technical background. The key decision makers included representatives from the U.S. Department of Energy (DOE), Ecology, and the U.S. Environmental Protection Agency (EPA).

Tables 1-2 and 1-3 identify the members of the DQO team and the key decision makers, respectively. These tables also identify the organization that each team member or decision maker represents and their technical areas of expertise.

Table 1-2. DQO Team Members. (2 Pages)

Name	Organization	Role and Responsibility
Bob Egge	BHI (S/M&T)	BHI Project Engineer
Stuart Kretzschmar	BHI (S/M&T)	Site knowledge, process history
Noel Kerr	BHI (S/M&T)	Site knowledge, process history
Duane Jacques	CHI	CHI task lead
Rich Weiss	CHI	Site knowledge, process history, COPCs
John Ludowise	CHI	Site knowledge, process history
Chris Kemp	BHI (S/M&T)	Site knowledge
Moses Jarayssi	BHI	Regulatory support
Greg Funnell	BHI	Operational support
Rick Woods	BHI (S/M&T)	BHI Task Lead

Table 1-2. DQO Team Members. (2 Pages)

Name	Organization	Role and Responsibility
Greg Borden	BHI	Waste management
Roger Ovink	CHI	DQO facilitator, workbook author
Artemis Antipas	CH2M Hill	DQO workbook author

BHI = Bechtel Hanford, Inc.
CHI = CH2M Hill Hanford, Inc.
S/M&T = Surveillance, Maintenance, and Transition (Project)

Table 1-3. DQO Key Decision Makers.

Name	Organization	Role and Responsibility
Bob Wilson	Ecology	Ecology Task Lead
Tracy Gao	Ecology	Ecology Project Support
Craig Cameron	EPA	EPA Task Lead
Tom Ferns	RL	RL Task Lead
Cliff Ashley	RL	RL Facility Representative

RL = U.S. Department of Energy, Richland Operations Office

1.7 PROJECT BUDGET AND CONTRACTUAL VEHICLES

Table 1-4 presents the known budgets for the tasks associated with project. For activities that need to be subcontracted, Table 1-4 presents the available contractual vehicles.

Table 1-4. Task Budget and Contractual Vehicles.

Task Activities	Budget	Contractual Vehicle
DQO workbook development	$54,740	BCP-20223, Rev. 0 (BHI 2000a)
Sampling and analysis plan development	TBD (based on DQO process)	N/A
Field implementation	TBD (based on DQO process)	N/A
Laboratory analyses	TBD (based on DQO process)	N/A
Data quality assessment	TBD (based on DQO process)	N/A
Documentation of investigation results	TBD (based on DQO process)	N/A

N/A = not applicable
TBD = to be determined

1.8 TRI-PARTY AGREEMENT MILESTONE (OR PROJECT SCHEDULE) DATES

Table 1-5 presents the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) milestone (or project schedule) dates for the completion of the tasks associated with the project.

Table 1-5. Milestone/Schedule Dates.

Task Activities	Milestone/Schedule Date
DQO workbook development	Project schedule: September 30, 2000
Sampling and analysis plan development	Project schedule: FY 2001
Field implementation	Project schedule: FY 2001
Laboratory analyses	Project schedule: FY 2001
Data quality assessment	Project schedule: FY 2001
Documentation of investigation results	Project schedule: FY 2001

1.9 CONTAMINANTS OF CONCERN

A list of the contaminants of concern (COCs) for the hexone tanks is generated by initially listing all of the COPCs based on historical process operations. Some of the COPCs are removed from the list if they are addressed under a separate sampling and analysis plan (SAP) or waste management plan. COPCs are also removed if they have a short half-life, are not regulated, are not risk drivers, or if process knowledge/analytical data confirms that insignificant levels are present.

1.9.1 List of Contaminants of Potential Concern

Table A-1 (Appendix A) identifies the COPCs for the hexone tanks, lists their Chemical Abstract Service numbers (CAS#), and identifies the rationale for their exclusion from further project consideration.

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

Media	Known or Suspected Source of Contamination	Type of Contamination (General)	COPCs (Specific)
Tank vapor	Uranium extraction or REDOX Plant processes	Volatile organic compounds	See Table A-1 (Appendix A)
Tank residue	Uranium extraction or REDOX Plant processes	Volatile organic compounds, semi-volatile organic compounds, metals, and radioisotopes	See Table A-1 (Appendix A)

1.9.2 Other Contaminant of Potential Concern Exclusions

Table 1-7 presents a list of the COPCs excluded from the current DQO process. These exclusions are based on physical laws, process knowledge, task focus, or other mitigating factors.

Table 1-7. Rationale for COPC Exclusions.

Media	COPCs	Rationale for Exclusion
Tank vapor	See Table A-1 (Appendix A)	See Table A-1 volatile organic compounds (Appendix A)
Tank residue	See Table A-1 (Appendix A)	See Table A-1 (Appendix A)

1.9.3 Final List of Contaminants of Concern

Table A-2 (Appendix A) presents the final list of COCs for each media to be carried through the remainder of the DQO process.

Table 1-8. Final List of COCs.

Media	COCs
Tank residue	See Table A-2 (Appendix A)

1.9.4 Distribution of Contaminants of Concern

Table 1-9 identifies how each COC arrived at the site and the fate and transport mechanisms (e.g., wind or water) that may have influenced their distribution (e.g., vertical or lateral).

Table 1-9. Distribution of COCs.

Media	COCs	How COC Arrived at Site	Fate and Transport Mechanisms	Expected Distribution (Heterogeneous/ Homogeneous)
Tank residue	All	Uranium extraction, REDOX Plant, or distillation processes	Tank leaks (contents leaving or water entering)	Homogeneous by physical state (residual materials could include liquids, solids, or mixtures)

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 1-10. This information is used later in the DQO process to support the evaluation of decision error consequences.

Table 1-10. 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 and the basis that applies to each of the COCs are presented in Table A-2 (Appendix A). The action levels presented in Table A-2 are based on regulatory thresholds and/or risk. The final numerical action levels will be set in DQO Step 5.

The precision of the radionuclide analysis for the liquid samples and the solid samples will be ±20% and ±35%, respectively. The accuracy of the radionuclide analysis for the liquid samples and the solid samples will be in the range of 70% to 130%. The precision and accuracy requirements for the chemical analytes are as identified and defined in the applicable EPA procedures referenced in Table A-2.

Table 1-11. List of Preliminary Action Levels.

Media	COCs	Preliminary Action Level	Basis
Tank residue	All (see Table A-2 in Appendix A)	See Table A-2 in Appendix A	See Table A-2 in Appendix A

1.12 CONCEPTUAL SITE MODEL

Conceptual site models can be revised as additional data become available. A goal of the DQO process is to develop sampling designs that confirm or reject conceptual models. Table 1-12 presents a tabular summary of the hexone tank conceptual model, identifying the COC sources; release mechanisms, migration pathways, potential receptors, and exposure scenarios.

Table 1-12. Tabular Depiction of the Conceptual Site Model.

(See description below.)

Media	COCs	Source	Release Mechanism	Migration Pathways	Potential Receptors
Exposure Scenario: Contact with or direct radiological exposure to tank residue during sampling or stabilization.					

The conceptual model of the tank residue suggests the possibility of two different kinds of material. The predominant material in the bottom of each tank is expected to be a uniform layer of residue estimated at up to 950 L (250 gal). This estimate is based on the portion of the tank contents found at the bottom of each tank that could not be evacuated through the tank risers. The residue layer in each tank is expected to be composed of a homogenous mixture composed primarily of corrosion materials from the tank combined with lesser amounts tributyl phosphate, normal paraffin hydrocarbons, hexone, radionuclides from the REDOX process, and possibly water.

The inventory in each tank may also contain up to 114 L (30 gal) of a tar-like material that was inadvertently added to the tank during the distillation process. This tar-like material is likely to be found in accumulations at both ends of the tank immediately beneath the tank risers. The tar-like material is expected to be a concentrated form of the tank constituents listed above (e.g., corrosion products, organic materials, and radionuclides from the REDOX process).

1.13 STATEMENT OF THE PROBLEM

In May 2000, a NOC was issued by Ecology regarding current operation of the 276-S-141/142 hexone tanks. In partial response to the NOC, this DQO process was initiated to develop a sampling and analysis strategy to provide waste verification and designation data. The data collected by this effort will be used to designate the residual materials in accordance with WAC 173-303 requirements. The data will also be used to support an engineering study during FY 2001 that will identify interim actions to stabilize the tank system and to support closure of the facility.

2.0 STEP 2 – IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQs) that address the problem identified in DQO Step 1 and the alternative actions (AAs) that would result from the resolution of the PSQs. The PSQs and AAs are then combined into decision statements (DSs). Table 2-1 presents the PSQs for the hexone tank. Table 2-2 presents the AAs. Table 2-3 presents the qualitative assessment of the severity of the consequences of taking an AA if it is incorrect. Finally, Table 2-4 presents the resulting DSs. This assessment takes into consideration human health and the environmental (e.g., flora/fauna) and economic and legal ramifications.

Table 2-1. Principal Study Questions.

PSQ #	Principal Study Question
1	Do the contaminant concentrations within the hexone tank contents exceed the TRU definition?[a]
2	Do the radionuclide concentrations within the hexone tank contents exceed the annual radiological exposure limits for human health protection under an industrial exposure scenario?
3	Do the constituents within the hexone tanks exceed the nonradiological exposure limits for human health protection under an industrial exposure scenario?
4	Does the hexone tank conceptual model properly reflect the chemical/physical characteristics and distribution of contaminants within the tanks?
5	Does the waste material radiological activity or chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?
5a	Does the waste material radiological activity exceed the disposal facility waste acceptance criteria limits?
5b	Do the waste material chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?
6	Is the waste material a dangerous[b], PCB, or asbestos waste?
6a	Is the waste material a listed dangerous waste?
6b	Is the waste material a characteristic dangerous waste (e.g., ignitable, corrosive, reactive, or toxic)?
6c	Is the waste material a toxic dangerous waste per Washington State criteria?
6c	Is the waste material a persistent dangerous waste per Washington State criteria?
6d	Is the waste material a PCB waste?
6e	Is the waste material asbestos-containing material?
7	Is the waste material land disposal restricted?

[a] Refer to Table 1-11 for scenario-specific action levels.
[b] The definition of dangerous waste also includes hazardous waste.
PCB = polychlorinated biphenyl
TRU = transuranic (waste)

Table 2-2. Alternative Actions. (2 Pages)

PSQ #	AA #	Alternative Action
1	1	If the contaminant concentrations within the hexone tank contents exceed the TRU definition, evaluate special remedial alternatives.
1	2	If the contaminant concentrations within the hexone tank contents do not exceed the TRU definition, evaluate conventional remedial action alternatives.
1	3	No action.
2	1	If the radionuclide concentrations within the hexone tank contents do not exceed the industrial exposure limits, the tanks may be evaluated for in situ remediation.
2	2	If the radionuclide concentrations within the hexone tank contents exceed the industrial exposure limits, the tanks may not be evaluated for in situ remediation.
2	3	No action.
3	1	If the constituents within the hexone tanks do not exceed the nonradiological industrial exposure limits, the tanks may be evaluated for in situ remediation.
3	2	If the constituents within the hexone tanks exceed the nonradiological industrial exposure limits, the tanks may not be evaluated for in situ remediation.
3	3	No action.
4	1	If the hexone tank conceptual models reflect the chemical/physical characteristics and distribution of contaminants within the tanks, use the models for remedial alternative selection and remedial action planning?
4	2	If the hexone tank conceptual models do not reflect the chemical/physical characteristics and distribution of contaminants within the tanks, revise the models prior to remedial alternative selection and remedial action planning.
4	3	No action.
5	1	The radiological activity of the waste material exceeds the disposal facility waste acceptance criteria limits. The waste material will be evaluated for chemical waste designation and disposition will be negotiated with the regulators.
5	2	The radiological activity of the waste material does not exceed the disposal facility waste acceptance criteria limits. The waste material will be evaluated for chemical waste designation and disposed in an approved facility.
5	3	The chemical and/or physical properties of the waste material exceed the disposal facility waste acceptance criteria limits. Disposition will be negotiated with the regulators.
5	4	The chemical and/or physical properties of the waste material exceed the disposal facility waste acceptance criteria limits. Treatment will be conducted so the waste material meets the disposal facility waste acceptance criteria limits. The waste material will be evaluated for chemical waste designation and disposed in an approved facility.
5	5	The chemical and/or physical properties do not exceed the disposal facility waste acceptance criteria limits. The waste material will be evaluated for chemical waste designation and disposed in an approved facility.
5	6	No action.
6	1	The waste material is a listed dangerous waste and receives a listed waste code.
6	2	The waste material is not a listed dangerous waste and is not regulated as such.

Table 2-2. Alternative Actions. (2 Pages)

PSQ #	AA #	Alternative Action
6	3	The waste material is a characteristic dangerous waste (e.g., corrosive, ignitable, reactive, and/or toxic) and receives a characteristic waste code.
6	4	The waste material is not a characteristic dangerous waste (e.g., corrosive, ignitable, reactive, and/or toxic) and is not regulated as such.
6	5	The waste material is a toxic dangerous waste per Washington State criteria and receives a toxic dangerous waste code.
6	6	The waste material is not a toxic dangerous waste per Washington State criteria and is not regulated as such.
6	7	The waste material meets the definition of a persistent dangerous waste per Washington State criteria.
6	8	The waste material does not meet the definition of a persistent dangerous waste per Washington State criteria.
6	9	The waste material is regulated due to PCB concentrations.
6	10	The waste material is not regulated due to PCB concentrations.
6	11	The waste material is regulated due to asbestos content.
6	12	The waste material is not regulated due to asbestos content.
6	13	No action.
7	1	The waste material is land disposal restricted. Treatment is imposed on the debris prior to disposal.
7	2	The waste material is not land disposal restricted. Treatment is not required for the debris prior to disposal. The debris will be disposed in an onsite facility without treatment.
7	3	No action.

Table 2-3. Consequences of Erroneous Alternative Actions.[a] (2 Pages)

PSQ #	AA #	Consequences of Erroneous Action	Severity (Severe/Moderate/ Not Severe)
1	1	Special remedial alternatives for the hexone tanks will be unnecessarily developed. The remedial alternative will unnecessarily incorporate costly and difficult processes for handling TRU-contaminated tank contents.	Low for risk; risk would be overstated; actual risk would be lower. Moderate for cost.
1	2	The remedial actions will not plan for special remedial alternatives necessary for handling TRU-contaminated tank contents. Consequently, these contents might be incorrectly managed and disposed. Workers could be exposed to unacceptable levels of TRU waste.	Potentially severe for risk.
2	1	The remedial alternative is incorrectly chosen, preventing consideration of in situ remediation. The tank contents are unnecessarily removed, treated, and disposed.	Low to moderate risk to human health or environment. Low to moderate for cost depending on remedial action.

Table 2-3. Consequences of Erroneous Alternative Actions.[a] (2 Pages)

PSQ #	AA #	Consequences of Erroneous Action	Severity (Severe/Moderate/ Not Severe)
2	2	The remedial alternative is incorrectly chosen, allowing consideration of in situ remediation. The tank contents are remediated in situ, resulting in exceedance of the radiological cleanup levels.	Low to moderate risk to human health or environment, depending on selected remedial alternative (limited waste volume in a buried tank). Low to moderate for cost depending on remedial action.
3	1	The remedial alternative is incorrectly chosen, preventing consideration of in situ remediation. The tank contents are unnecessarily removed, treated, and disposed.	Low to moderate risk to human health or environment. Low to moderate for cost depending on remedial action.
3	2	The remedial alternative is incorrectly chosen, allowing consideration of in situ remediation. The tank contents are remediated in situ, resulting in exceedance of the nonradiological cleanup levels.	Low to moderate risk to human health or environment, depending on selected remedial alternative (limited waste volume in a buried tank). Low to moderate for cost depending on remedial action.
4	1	Remedial alternatives could underestimate the volume of the tank contents or the physical orientation within the tanks.	Low to moderate.
4	2	The site may be remediated beyond what is required, resulting in unnecessary expenditure of funds.	Low; no risk to human health or the environment.

[a] The DQO template for waste designation does not consider the consequences of erroneous decisions; therefore, the waste designation decisions are not included in this table.

Table 2-4. Decision Statements. (2 Pages)

DS #	Decision Statement
1	Do the contaminant concentrations within the hexone tank contents exceed the TRU definition?[a]
2	Do the radionuclide concentrations within the hexone tank contents exceed the annual radiological exposure limits for human health protection under an industrial exposure scenario?
3	Do the constituents within the hexone tanks exceed the nonradiological exposure limits for human health protection under an industrial exposure scenario?
4	Does the hexone tank conceptual model properly reflect the chemical/physical characteristics and distribution of contaminants within the tanks?
5	Does the waste material radiological activity or chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?
5a	Does the waste material radiological activity exceed the disposal facility waste acceptance criteria limits?
5b	Do the waste material chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?
6	Determine if the hexone tank contents designate as dangerous, PCB, or asbestos waste.

Table 2-4. Decision Statements. (2 Pages)

DS #		Decision Statement
	6a	Determine if the hexone tank contents are regulated as listed dangerous waste.
	6b	Determine if the characteristic waste codes (e.g., corrosivity, ignitability, reactivity, and toxicity) apply to the hexone tank contents.
	6c	Determine if the hexone tank contents meet the definition of a toxic dangerous waste per Washington State criteria.
	6d	Determine if the hexone tank contents meet the definition of a persistent waste per Washington State criteria.
	6e	Determine if the hexone tank contents are regulated due to PCB concentrations.
	6f	Determine if the hexone tank contents are regulated due to asbestos content.
7		Determine if land disposal restrictions impose treatment for hexone tank contents.

[a] Refer to Table 1-11 for scenario-specific action levels.

3.0 STEP 3 – IDENTIFY INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the data needed to resolve the DSs. This data may already exist or new data may be required.

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-1 specifies the information (i.e., data) required to resolve the DSs identified in Table 2-4 and indicates whether the data already exist. Source references for the existing data are provided with a qualitative assessment as to whether the data are of sufficient quality to resolve the DSs. The qualitative assessment of the existing data is based on the evaluation of laboratory quality control data (e.g., spikes, duplicates, and blanks), detection limits, and data collection methods.

Table 3-1. Required Information and Reference Sources. (2 Pages)

DS #	Remediation Variable	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality (Y/N)	Additional Information Required? (Y/N)
1 and 5a	Concentrations of TRU constituents	TRU constituent activity in tank residue	Y	Process knowledge, sample data	N	Y
2 and 5a	Concentrations of radiological constituents	Radiological activity in tank vapors	Y	Process knowledge, sample data	Y	N [a]
		Radiological activity in tank residue	Y	Limited process knowledge	N	Y
3, and 5b	Concentration of chemical constituents	Chemical constituent concentrations in tank vapors	Y	Process knowledge, sample data	Y	N [a]
		Chemical constituent concentrations in tank residue	Y	Limited process knowledge	N	Y
4	Conceptual model (chemical, physical characteristics)	Residue volume and matrix	Y	Historical estimates	N	Y
		Residue physical nature	N	Limited process knowledge	N/A	Y
6	Concentration of chemicals in tank residue	Refer to Table 3-2				

Table 3-1. Required Information and Reference Sources. (2 Pages)

DS #	Remediation Variable	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality (Y/N)	Additional Information Required? (Y/N)
7	Concentration of chemicals in the waste material	Compliance with land disposal restrictions	N	--	N/A	Y

[a] Vapor samples collected in March 1999 and September 1999 (as reported in USQ 0200W-US-N0144-02, Rev. 1 [BHI 2000b]).
N/A = not applicable

Table 3-2. Waste Designation Inputs.

DS #	Characterization Requirement	Regulatory Criteria	Required Information/Media	Do Data Exist? (Y/N)	Source	Sufficient Quality? (Y/N)	More Info Req'd? (Y/N)
6a	Determine if the waste material is regulated as a listed dangerous waste.	WAC 173-303-080, -081, and –082	Listed waste processes or chemicals	Y	Dangerous Waste Permit Application	Y	N
6b	Determine if the characteristic dangerous waste codes (e.g., corrosivity, ignitability, reactivity) apply.	WAC 173-303-090(2)-(8)	Corrosivity, ignitability, reactivity	Y		Y	N
	Determine if the characteristic dangerous waste code (e.g., toxicity) applies.		Totals and/or TCLP concentrations for RCRA metals	N	--	N	Y
6c	Determine if the waste material meets the definition of a toxic dangerous waste per Washington State criteria (i.e., wastes with equivalent concentrations of toxic components of >0.001%).	WAC 173-303-100, WAC 173-303-100[5]	State toxic waste definition	Y	Dangerous Waste Permit Application	Y	N
6d	Determine if the waste material meets the definition of a persistent dangerous waste per Washington State criteria (i.e., wastes that contain a total concentration of halogenated organic carbons ≥0.01%, or a total concentration of polycyclic aromatic hydrocarbons ≥1.0%).	WAC 173-303-100	State persistent waste definition	N	Dangerous Waste Permit Application	Y	N
6e	Determine if the waste material is regulated due to PCB concentrations.	40 CFR 761 WAC 173-303-9904	PCB concentrations	N	N	N	Y
6f	Determine if the waste material is regulated due to asbestos concentrations.	40 CFR 61, Subpart M	Presence of asbestos-containing material	Y	Process knowledge	Y	N

CFR = *Code of Federal Regulations*
RCRA = *Resource Conservation and Recovery Act of 1976*
TCLP = toxicity characteristic leachate procedure

3.2 BASIS FOR SETTING THE ACTION LEVEL

Action levels are threshold values that provide the criteria for choosing between AAs (i.e., remediation or "no action"). Table 3-3 identifies the basis (i.e., regulatory threshold or risk-based) for establishing action levels for each COC. The COC action levels for the hexone tanks are presented Appendix A (Table A-2) and in DQO Step 5 (Tables 5-2 and 5-3).

Table 3-3. Basis for Setting Action Level.

DS #	Remediation Variable	COCs	Basis for Setting Action Level
1 and 5a	Concentrations of TRU constituents	TRU radionuclides	TRU definition
2 and 5a	Concentrations of radiological constituents	Radioisotopes	Industrial scenario dose limit (assumed to be 100 mrem/yr above background), disposal facility waste acceptance criteria
3 and 5b	Concentration of chemical constituents	Organics, inorganic chemicals, metals	WAC 173-303; WAC 173-340; ERDF waste acceptance criteria
4	Conceptual model (chemical, physical characteristics)	N/A	N/A
6	Concentration of chemicals in tank residue	Dangerous wastes	Refer to Table 3-2
7	Concentration of chemicals in the waste material	Land disposal restricted constituents	

ERDF = Environmental Restoration Disposal Facility
N/A = not applicable

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-1 identifies the DSs where existing data either do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table 3-4 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-4. Information Required to Resolve the Decision Statements.

DS #[a]	Remediation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1 and 5a	Concentrations of TRU constituents	TRU constituent activity in tank residue	N/A	Laboratory analysis
2 and 5a	Concentrations of radiological constituents	Radiological activity in tank residue	RESRAD	
3 and 5b	Concentration of chemical constituents	Chemical constituent concentrations in tank residue	N/A	
4	Conceptual model (chemical, physical characteristics)	Vapor volume and matrix	N/A	Direct physical observation and measurements
		Residue volume and matrix		
		Residue physical nature		
		Residue physical state (liquid, solid, mix)		
6	Listed dangerous waste status	Process knowledge about materials	N/A	Process knowledge.
	Characteristic dangerous waste code status	Physical properties and chemical concentrations	N/A	Process knowledge and/or standard laboratory methods.
	Toxic dangerous waste code status	Process knowledge, reference evaluation	N/A	Standard laboratory methods and engineering calculation.
	Persistent dangerous waste code status	Physical properties and chemical concentrations	N/A	Process knowledge and/or standard laboratory methods.
	PCB concentrations	Physical properties and chemical concentrations	N/A	Process knowledge and/or standard laboratory methods.
	Asbestos-containing material	Physical properties and chemical concentrations	N/A	Process knowledge and/or standard laboratory methods.
7	Land disposal restrictions	Physical properties and chemical concentrations	N/A	Process knowledge and/or standard laboratory methods.

[a] Hexone tank vapors are not included because additional data needs were not identified in Table 3-1.
N/A = not applicable
RESRAD = RESidual RADioactivity dose model

Table 3-5 presents details on the computational methods identified in Table 3-4.

Table 3-5. Details on Identified Computational Methods.

DS #[a]	Computational Method	Source/Author	Application to Study
2	RESRAD	Argonne National Laboratory	Estimate direct radiation dose for occupational workers

Table 3-6 identifies each of the survey and/or analytical methods that may be used to provide the required information needed to resolve each of the DSs. The possible limitations associated with each of these methods are also provided with the estimated cost.

Table 3-6. Potentially Appropriate Survey/Analytical Methods.

DS #[a]	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations	Cost
1 and 5a	Concentrations of TRU constituents	Laboratory analysis	Sampling error, laboratory error	High
2 and 5a	Concentrations of radiological constituents			Moderate
3 and 5b	Concentration of chemical constituents			
4	Conceptual model (chemical, physical characteristics)	Camera/video	Flammable environment	$30,000[b]
6	Concentration of chemicals in tank residue	Laboratory analysis	Sampling error, laboratory error	Moderate
7	Concentration of chemicals in the waste material			

[a] Tank vapors are not included because no additional data needs were identified for them in Table 3-1.
[b] This estimated cost would cover the camera/video effort to resolve DS #4 .

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Table A-2 (Appendix A) defines the analytical performance requirements for the data that need to be collected to resolve each of DS. These performance requirements include the practical quantitation limit (PQL) and precision and accuracy requirements for each COC.

Table 3-7. Analytical Performance Requirements.

DS #	COCs	Survey/ Analytical Method	Preliminary Action Level	PQL	Precision Req't	Accuracy Req't
1	TRUs	Laboratory analysis	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)
2	Radionuclides		See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)
3	Organics/metals		See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)
4	N/A	Camera	N/A	N/A	N/A	N/A
5	N/A	Survey elevation	N/A	N/A	±0.5 in.	±0.5 in.
6	N/A	Camera/video	N/A	N/A	N/A	N/A
7	Land disposal restricted concentrations	Laboratory analysis	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)	See Table A-2 (Appendix A)

N/A = not applicable

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

The objective of DQO Step 4 is to identify the population of interest, define the spatial and temporal boundaries that apply to each DS, define the scale of decision making, and identify practical constraints that must be considered in the sampling design. Completing this step helps ensure that the data collected will accurately reflect the true condition of the site being investigated.

4.1 POPULATION OF INTEREST

Prior to defining the spatial and temporal boundaries of the site under investigation, it is first necessary to define the populations of interest that apply to each DS. The intent of Table 4-1 is to define the attributes of 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	Unit Measurement Size	Total Number of Potential Measurement Units Within the Population
1	Tank residue	10 g[a]	Unknown
2 through 7	Tank residue	1 L (0.3 gal)[a]	Unknown

[a] Optimal volume, which may be adjusted downward to accommodate retrieval of a lesser amount of sample. Minimum sample size will be defined in the sample authorization form.

4.2 GEOGRAPHIC BOUNDARIES

Table 4-2 identifies the geographic boundaries for each DS. Identifying the boundaries of the study area ensures that the investigation will not expand beyond the original scope of the task.

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	The REDOX Facility in 200 West Area.

4.3 ZONES WITH HOMOGENEOUS CHARACTERISTICS

Table 4-3 defines the zones within the site that have relatively homogeneous characteristics. These zones are identified by using existing information to segregate the elements of the population into subsets that exhibit relatively homogeneous characteristics (e.g., types of contaminants). Dividing the site into homogeneous zones reduces the overall complexity of the problem by breaking the site into more manageable pieces.

Table 4-3. Zones with Homogeneous Characteristics.

DS #	Population of Interest	Zone	Homogeneous Characteristic Logic
All	Tank residue accumulations	Areas on the tank bottom, immediately beneath the tank risers at opposite ends of the tank	Tank residue accumulation consisting of the following: - Tank residuals that were not pumped out from previous tank evacuation. - Tar pumped into the tank from the distillation tank through the tank risers.
		The area on the tank bottom between the tank man-way port and the tank riser	Tank residuals that were not pumped out from previous tank evacuation.

4.4 TEMPORAL BOUNDARIES

Table 4-4 identifies temporal boundaries that may apply to each DS. Temporal boundaries refer to the timeframe over which each DS applies (e.g., number of years) and when (e.g., season, time of day, and weather conditions) data to resolve each DS should optimally be collected.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
All	5 years (5-year review cycle)	No restrictions
	FY 2001	No restrictions

4.5 SCALE OF DECISION MAKING

Table 4-5 documents the scale of decision making for each DS.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Scale of Decision
			Timeframe	When to Collect Data	
All	Tank residue constituents	The REDOX Facility in 200 West Area	5 years (5-year review cycle)	No restrictions	The zones immediately beneath the tank risers at opposite ends of the tank that contain tank residuals and tars pumped from the distillate tank.
			FY 2001	No restrictions	The area on the tank bottom between the two tank risers, that does not contain tars pumped from the distillation tank.

4.6 PRACTICAL CONSTRAINTS

Table 4-6 identifies practical constraints that may influence data collection efforts (e.g., physical barriers, difficult sample matrices, and high radiation areas).

Table 4-6. Practical Constraints on Data Collection.

1. Tank access will be restricted through risers (4-in. diameter) and manholes (24-in. diameter). This constraint will influence sampling device and camera selection.
2. There will be worker health and safety issues concerning tank vapors. This constraint will influence sampling device and camera selection.
3. Potentially high radionuclide contamination. Potentially TRU which will influence handling and disposal.
4. The tank residue could be difficult to sample due to its physical nature.
5. The tank residue could be difficult to analyze due to "matrix" effects. This will influence analyte detection limits.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of DQO Step 5 is to define the statistical parameters of interest (e.g., mean or median) that will be used for comparison against the action levels. Also in DQO Step 5, decision rules (DRs) (i.e., "IF…THEN…" statements) are developed for each DS. The DRs typically incorporate the parameter of interest, the scale of decision making (from DQO Step 4), the action level (from Appendix A), and the AAs (from DQO Step 2) that would result from resolution of the DS.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1 and 5-2 summarize some of the information needed to formulate the DRs. This information includes the DS and the statistical parameters of interest.

Table 5-1. Decision Statements. (2 Pages)

DS #	Decision Statement
1	Do the contaminant concentrations within the hexone tank contents exceed the TRU definition?
2	Do the radionuclide concentrations within the hexone tank contents exceed the annual radiological exposure limits for human health protection under an industrial exposure scenario?
3	Do the constituents within the hexone tanks exceed the nonradiological exposure limits for human health protection under an industrial exposure scenario?
4	Does the hexone tank conceptual model properly reflect the chemical/physical characteristics and distribution of contaminants within the tanks?
5	Does the waste material radiological activity or chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?
5a	Does the waste material radiological activity exceed the disposal facility waste acceptance criteria limits?
5b	Do the waste material chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?

Table 5-1. Decision Statements. (2 Pages)

DS #		Decision Statement
6		Determine if the hexone tank contents designate as dangerous, PCB, or asbestos waste.
	6a	Determine if the hexone tank contents are regulated as listed dangerous waste.
	6b	Determine if the characteristic waste codes (e.g., corrosivity, ignitability, reactivity, and toxicity) apply to the hexone tank contents.
	6c	Determine if the hexone tank contents meet the definition of a toxic dangerous waste per Washington State criteria.
	6d	Determine if the hexone tank contents meets the definition of a persistent waste per Washington State criteria.
	6e	Determine if the hexone tank contents are regulated due to PCB concentrations.
	6f	Determine if the hexone tank contents are regulated due to asbestos content.
7		Determine if land disposal restrictions impose treatment for hexone tank contents.

Table 5-2. Statistical Parameter of Interest. (2 Pages)

DS#	Decision Statement	Parameter of Interest
1	Contaminant concentrations exceed the TRU definition?	Maximum detected value
2	Radionuclide concentrations exceed the annual radiological exposure limits for human health protection?	95% UCL of the mean, maximum, or single sample analytical concentration (as applicable)
3	Constituents exceed the nonradiological exposure limits for human health protection?	
4	Conceptual models reflect the chemical/physical characteristics and distribution of contaminants?	Observed values
5a	Radiological activity exceeds the disposal facility waste acceptance criteria limits?	80% UCL of the mean, maximum, or single sample analytical concentration (as applicable)
5b	Chemical and/or physical properties exceed the disposal facility waste acceptance criteria limits?	
6	Determine if the waste material designates as dangerous, PCB, or asbestos waste.	Process knowledge, or analytical results: 80% UCL, or single sample concentrations.
6a	Determine if the waste material is regulated as listed dangerous waste.	
6b	Determine if the characteristic dangerous waste codes (e.g., corrosivity, ignitability, reactivity, and toxicity) apply to the waste material.	

Table 5-2. Statistical Parameter of Interest. (2 Pages)

DS#	Decision Statement	Parameter of Interest
6c	Determine if the waste material meets the definition of a toxic dangerous waste per Washington State criteria.	
6d	Determine if the waste material meets the definition of a persistent dangerous waste per Washington State criteria.	
6e	Determine if the waste material is regulated due to PCB concentrations.	
6f	Determine if the waste material is regulated due to asbestos content.	N/A
7	Determine if land disposal restrictions impose treatment for waste material.	Process knowledge, material safety data sheet data. <u>Analytical results</u>: Analytical results of any grab sample to impose treatment. Favorable analytical results for all grab samples to avoid treatment.

N/A = not applicable
UCL = upper confidence level

5.2 DECISION RULES

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

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

DS #	DR #	Decision Rule[a]
1	1	If the maximum detected sampling results from the hexone tank contents exceed the TRU definition of 100 nCi/g, then analyze the nonradiological constituents and evaluate the need for special remedial action alternatives. If the maximum detected sampling results from the hexone tank contents do not exceed the TRU definition of 100 nCi/g, then evaluate the other radiological constituents and the nonradiological constituents in accordance with DRs #2 and 3.
2	2	If the RESRAD analysis of 95% UCL of the mean, the maximum, or single sample analytical concentration (as applicable) detected sampling results for the radiological COCs from the hexone tank contents do not exceed the annual exposure limits for human health protection, then the tanks may be continue to be evaluated for in situ remediation via DR #3. If the RESRAD analysis of 95% UCL of the mean, the maximum, or single sample analytical concentration (as applicable) detected sampling results for the radiological COCs from the hexone tank contents exceeds the annual exposure limits for human health protection, then the tanks may not be evaluated for in situ remediation. Analyze the nonradiological constituents in accordance with DR #3.

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

DS #	DR #	Decision Rule[a]
3	3	If the 95% UCL of the mean, the maximum, or single sample analytical concentration (as applicable) detected sampling results for the nonradiological COCs from the hexone tank contents do not exceed the respective nonradiological COC action levels for direct exposure, then the tanks may be evaluated for in situ remediation. If the 95% UCL of the mean, the maximum, or single sample analytical concentration (as applicable) detected sampling results for the nonradiological COCs from the hexone tank contents exceed the respective nonradiological COC action levels for direct exposure, then the tanks may not be evaluated for in situ remediation.
4	4	If the detected values for the chemical/physical characteristics and distribution of contaminants within the hexone tanks properly reflect the conceptual model, use the model for remedial alternative selection and remedial action planning. If the detected values for the chemical/physical characteristics and distribution of contaminants within the hexone tanks do not properly reflect the conceptual model, revise the model prior to remedial alternative selection and remedial action planning.
5a	5a	If the 80% UCL of the mean, maximum, or single sample radiological analytical results from the hexone tank contents indicate that the radiological activity exceeds the disposal facility waste acceptance criteria limits, then the tank contents will be evaluated for compliance with nonradiological constituents, and disposition options will be discussed with the regulators. If the 80% UCL of the mean, maximum, or single sample radiological analytical results from the hexone tank contents indicate that the radiological activity does not exceed the disposal facility waste acceptance criteria limits, then the tank contents will be evaluated for compliance with nonradiological constituents in accordance with DR #5b.
5b	5b	If the 80% UCL of the mean, maximum, or single sample nonradiological analytical results (as applicable) indicate that the nonradiological constituent concentrations exceed the disposal facility waste acceptance criteria limits, then the material will be evaluated for chemical waste designation, and disposition options will be discussed with the regulators. If the 80% UCL of the mean, maximum, or single sample nonradiological analytical results (as applicable) indicate that the nonradiological constituent concentrations do not exceed the disposal facility waste acceptance criteria limits, then the material will be evaluated for chemical waste designation in accordance with DR #6.
6	6	If process knowledge, or the 80% UCL of the mean, or single sample concentrations (as applicable) of the detected analytical value indicate that the waste material does not designate as dangerous or PCB waste, then the material will be designated as non-dangerous waste. If process knowledge, or the 80% UCL of the mean, or single sample concentrations (as applicable) of the detected analytical value indicate that the waste material designates as dangerous or PCB waste, then the material will be evaluated for treatment and onsite disposal in accordance with DR #7.
7	7	If the analytical results of any grab sample indicate that land disposal restriction imposed treatment is required, then treat the waste material, resample, and evaluate for disposal. If all of the grab sample analytical sample results indicate that land disposal restriction imposed treatment is not required for the waste material, then dispose in an onsite waste disposal facility.

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Analytical data can only estimate the true condition of the site under investigation. Therefore, decisions made based on analytical data could be in error (i.e., decision error). For this reason, the objective of DQO Step 6 is to determine if the DSs require statistically based sample designs. For each DS requiring a statistically- based sample design, DQO Step 6 defines tolerable limits for making decision errors.

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN

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

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

DS #	Timeframe (Years)	Qualitative Consequences of Inadequate Sampling Design (Low/Moderate/Severe)	Resampling Access After Remediation (Accessible/Inaccessible)	Proposed Sampling Design (Statistical/ Non-Statistical)
1	5	Potentially severe	Accessible	Judgmental/statistical
2 through 7	5	Low/moderate	Accessible	Non-statistical

6.2 NON-STATISTICAL DESIGNS

For each DS to be resolved using a non-statistical design, there is no need to complete Sections 6.3, 6.4, 6.5, or 6.6 because the DSs only apply to statistical designs. Refer to Section 7.1 for details on developing non-statistical sampling designs.

The non-statistical design is dictated by the access limitation to the tank and the nature of the matrix. The proposed judgmental design is expected to provide comprehensive data to establish the concentration levels in the tank residue. The design will access the samples through risers and manholes to provide for comprehensive characterization. Replicate samples will be collected for estimated mean concentrations.

6.3 JUDGMENTAL/STATISTICAL DESIGNS

The judgmental/statistical design used for the transuranic (TRU) and conceptual model determinations will employ the phased sampling design concept developed for the 105-C fuel storage basin. This design concept is also included as a contingency sampling design in the 100 Area Remaining Sites SAP (DOE-RL 2000). The *Data Quality Objectives Summary Report for the Release of the 105-C Below-Grade Structures and Underlying Soils* (BHI 1999) developed the phased sampling concept in detail and is, therefore, referenced for the DQO Step 6 statistical design portion of this summary report.

7.0 STEP 7 – OPTIMIZE THE DESIGN

The objective of DQO Step 7 is to develop alternative sampling designs that meet the data quality requirements specified in DQO Steps 1 through 6. A selection process is used to identify the most resource-effective data collection design that satisfies the project data quality requirements. Discussion in DQO Step 6 differentiated between the DSs requiring statistical sampling designs from DSs that require non-statistical designs.

7.1 NON-STATISTICAL DESIGN

7.1.1 Non-Statistical Screening Method Alternatives

Table 7-1 identifies all of 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
2 and 5	Tank residue, radiological constituents	NaI probe or remote-reading dosimeter	Enter tanks through risers and/or manholes	Riser/manhole diameters (4—in. and 24-in.) Spark-proof equipment Instrument accuracy	Low
3, 6, and 7	Tank residue, chemical constituents	N/A	N/A	N/A	N/A
4	Tank residue, chemical and physical properties	Photo/video Elevation surveys	Enter tanks through risers and/or manholes	Riser/manhole diameters (4—in. and 24-in.) Spark-proof equipment	Low

N/A = not applicable
NaI = sodium iodide

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 the alternative methods for collecting samples. This table presents alternative implementation designs for each sampling method and identifies limitations associated with each sampling method and/or design. An estimated cost for each sampling design is provided for comparison purposes.

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

DS #	Media	Sampling Method	Potential Implementation Designs	Limitations	Cost
2 and 5	Tank residue, radiological constituents	Collect discrete sample using remote sampling device.	Enter tanks through risers and/or manholes.	Riser/manhole diameters (4- and 24-inches) Spark-proof equipment Laboratory limits on sample radioactivity Difficult to sample multiple matrices	High
3, 6, and 7	Tank residue, chemical constituents	Collect discrete sample using remote sampling device.	Enter tanks through risers and/or manholes.	Riser/manhole diameters (4- and 24-in.) Spark-proof equipment Laboratory limits on sample radioactivity Difficult to sample multiple matrices	High
4	Tank residue, chemical and physical properties	N/A	N/A	N/A	N/A

N/A = not applicable

7.2 SAMPLING DESIGN

The selected sampling design employs an observational sampling strategy that is intended to verify the conceptual model for the tanks and also provide empirical data to address the decisional requirements. The stages of the sampling design, and their bases are described in the following subsections.

7.2.1 Stage I – Video Record

The initial portion of the sampling design consists of remote video camera deployment into the tanks through the 4-in.-diameter risers or the 24-in.-diameter manhole to document the internal conditions of the tanks and to verify the conceptual model of the tank residue configurations. This operation is critical and is the foundation of all subsequent sampling activities.

If the Stage I video survey reveals that the conceptual model is erroneous, the sampling design will be revised accordingly to accommodate the data quality requirements of this project. In this case, the video results will be examined by tank sampling experts for consultation. If the Stage I video record verifies the conceptual model, the sampling design will remain unchanged.

7.2.2 Stage II – Non-Statistical Sampling

Stage II sampling supports DRs #2 through #7, which do not require a statistical sampling design. The sampling performed in Stage II will include physical sampling of the tank contents from both the 24-in.-diameter manhole and the 4-in.-diameter riser. One sample will be collected from the tar residue under each access port in each tank. In addition, if sampling conditions allow, one sample will be collected from the region between the two access ports to characterize the residual sludge media expected on the tank bottom. Finally, one duplicate sample will be collected from the tar residue under the large-diameter manhole in each tank, yielding a maximum of four samples per tank.

7.2.3 Stage III – Judgmental/Statistical Sampling

This portion of the sampling design focuses on resolving DR #1. It is essential to provide a statistically significant determination for the TRU decision because of the potentially significant consequences of a wrong decision. As discussed in DQO Step 6, this stage of the sampling design employs the phased sampling concept used to release the 105-C fuel storage basin.

The first phase of this sampling design is judgmental, requiring collection of five Phase I samples from the tar residue at the bottom of the tanks. Four samples will be collected from the 24-in.-diameter manhole and one sample will be collected from the 4-in.-diameter riser from each tank. These samples will only be analyzed for the TRU isotopes. If all sample results indicate that the total of all TRU isotope concentrations are below the TRU limit of 100 nCi/g, a variance analysis will be performed on the analytical results obtained from the Phase I samples. If the variance analysis indicates that the variability between the five Phase I samples is within an acceptable range, there will be no need for further sampling to support the TRU decision. If, however, the variability value determined from the Phase I sampling indicates that additional sampling is required to support the TRU decision, the project team will evaluate the costs and benefits associated with further characterization or remedial action planning for TRU waste disposition.

The results of the Stage I video image shall be used to support the Stage III sampling design. The four samples collected from under the 24-in.-diameter manhole should be spaced as far apart in the X-Y plane as is practically achievable to avoid co-located sampling. In addition, samples should be collected from varying depths within the tar residue, if possible.

It should be noted that although the Stage II and Stage III sampling are presented as uniquely different, the samples may be shared as long as adequate sample media are obtained.

The sampling design is summarized in Table 7-3.

Table 7-3. Key Features of the Sampling Design. (2 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Stage I		
Video/photo record	Lower spark-proof camera into tanks through the 4-in.-diameter riser or 24-in. manhole. Scan tank walls and residue to establish wall corrosion status and residue footprint (length and width dimensions).	Need to obtain visual record of the tank interior configuration to confirm the conceptual model and provide the basis for subsequent sampling activities.
Elevation surveys	Lower spark-proof survey rod or probe into tanks through 4-in. riser or 24-in. manhole. Shoot elevation with rod on top of residue and on the tank wall below the residue (at the deepest part of the tank wall curve).	Establish the maximum residue depth.
Tar residue- matrix	Photo/video	Lower spark-proof camera into tanks through two or more risers or manholes. Obtain photo and/or video record of the residue in a normal state and while manipulating the residue with the survey rod (to determine if it is multi-phase).
Stage II		
Non-statistical sampling	Collect two samples of tar residue. One sample to be obtained from under each of the access ports in each tank	Use spark-proof sampling tools. Sampling to resolve DRs #2 through #7. Analyze for all constituents in Table A-2, except for TRU isotopes.
	Collect one sludge sample from the tank bottom area between the access ports.	
	Collect one duplicate sample from the tar residue under the 24-in.-diameter manhole.	
Stage III		
Phase I statistical sampling	Collect four samples of tar residue from under the 24-in.-diameter manhole.	If all sample results indicate that the total of all TRU isotope concentrations are below the TRU limit of 100 nCi/g, perform a variance analysis on the 5 samples to determine the need for additional sampling to support the TRU decision. If the variance analysis indicates that five samples are adequate for the decision based on variability, no further sampling will be required. If the variance analysis indicates that additional sampling is required, the project team will evaluate the costs and benefits of further characterization against disposal of the tar residue as TRU waste.
	Collect one sample of tar residue from under the 4-in.-diameter riser.	

Table 7-3. Key Features of the Sampling Design. (2 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Phase II statistical sampling	Calculate the number of additional samples required to resolve the TRU decision. Collect the designated number of samples from the access ports in the tanks. Because of access limitations, the majority of the samples should be collected from the 24-in.-diameter manhole.	Collection of the statistically derived number of samples to resolve the TRU decision. Analyze only for TRU isotopes.

7.2.4 Sampling Design Limitations

The sampling design developed in this DQO summary report has several potential limitations that may affect the sampling results. Some of the factors that have the potential to affect the outcome of this sampling effort include the following:

1. The tar accumulation on the tank bottom may be in the form of a very thin layer that may not support the Phase II and III sampling designs. In this case, the project decision makers (i.e. the U.S. Department of Energy, Richland Operations Office and the regulatory agencies) will be consulted. It is likely that sampling would proceed on the basis of collecting the tar residues to the extent practicable. If sample volumes recovered are not sufficient to support the full suite of analyses planned, the analyses will follow a prescribed list of priorities that will be defined in the SAP.

2. Access limitations may hinder sampling efforts through the tank risers and access ports. If the restrictions are severe and it is apparent that the sampling requirements will not be met, the project decision makers will be consulted.

3. Because the samples retrieved from the tank may contain TRU-contaminated materials, it is possible that analyses will be conducted in an onsite laboratory. In this case, impacts may include degraded detection limits for certain analytes, reduced analyte lists, and long turnaround times.

8.0 REFERENCES

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40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended.

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APPENDIX A

276-S-141/142 HEXONE TANK CONTAMINANT OF POTENTIAL CONCERN AND CONTAMINANT OF CONCERN LISTS

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Actinium-225	14265-85-1	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Actinium-227	14952-40-0	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Aluminum-28	N/A	Short-lived radionuclide (half-life <3 years)
Americium-241	14596-10-2	
Americium-242	13981-54-9	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-242m	13981-54-9	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-243	14993-75-0	Constituent with atomic mass number greater than or equal to 242 that represents < 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Antimony-122	14374-79-9	Short-lived radionuclide (half-life <3 years)
Antimony-123		Stable, not radioactive
Antimony-124	14683-10-4	Short-lived radionuclide (half-life <3 years)
Antimony-125	14234-35-6	Short-lived radionuclide (half-life <3 years)
Antimony-126	15756-32-8	Short-lived radionuclide (half-life <3 years)
Antimony-126m	15756-32-8	Short-lived radionuclide (half-life <3 years)
Astitine-217	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Barium-133	13981-41-4	No apparent source in the 200 Areas (GEA will report if detected)
Barium-135m	14698-58-9	Short-lived radionuclide (half-life <3 years)
Barium-137		Stable, not radioactive
Barium-137m	N/A	Short-lived daughter of Cs-137 (which is a final COPC)
Barium-140	14798-08-4	Short-lived radionuclide (half-life <3 years)
Beryllium-10	N/A	No apparent source in the 200 Areas (no standard analytical procedure available)
Beryllium-7	13966-02-4	Short-lived radionuclide (half-life <3 years)
Bismuth-210	14331-79-4	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Bismuth-211	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Bismuth-212	14913-49-6	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Bismuth-213	15776-20-2	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Bismuth-214	14733-03-0	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Cadmium-109	14109-32-1	Short-lived radionuclide (half-life <3 years)
Cadmium-113m	14336-66-4	Less than 1% of Cs-137 activity. Insignificant contribution to dose; no standard analytical detection methodology available.
Carbon-14	14762-75-5	
Cerium-141	13967-74-3	Short-lived radionuclide (half-life <3 years)
Cerium-144	14762-78-8	Short-lived radionuclide (half-life <3 years)
Cesium-134	13967-70-9	Short-lived radionuclide (half-life <3 years)

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Cesium-135	15726-30-4	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Cesium-137	10045-97-3	
Chlorine-36	13981-43-6	No apparent source in the 200 Areas (no standard analytical procedure available)
Chromium-51	14392-02-0	Short-lived radionuclide (half-life <3 years)
Cobalt-57	13981-50-5	Short-lived radionuclide (half-life <3 years)
Cobalt-58	13981-38-9	Short-lived radionuclide (half-life <3 years)
Cobalt-60	10198-40-0	
Curium-242	15510-73-3	Short-lived radionuclide (half-life <3 years)
Curium-243	15757-87-6	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-244	13981-15-2	
Curium-245	15621-76-8	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-246	15757-90-1	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Einsteinium-254	15840-03-6	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Europium-152	14683-23-9	
Europium-154	15585-10-1	
Europium-155	14391-16-3	
Francium-221	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Francium-223	15756-98-6	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Gadolinium-152	14867-54-0	Naturally occurring isotope not created in Hanford reactor operations.
Gadolinium-153	14276-65-4	Short-lived radionuclide (half-life <3 years)
Germanium-68	15756-77-1	Short-lived radionuclide (half-life <3 years)
Gold-195	14320-93-5	Short-lived radionuclide (half-life <3 years)
Hydrogen-3	10028-17-8	
Iodine-123	15715-08-9	Short-lived radionuclide (half-life <3 years)
Iodine-125	14158-31-7	Short-lived radionuclide (half-life <3 years)
Iodine-129	15046-84-1	Constituent generated at less than 5E-5 times Cs-137 activity, historical tank sampling indicates nondetection
Iodine-131	10043-66-0	Short-lived radionuclide (half-life <3 years)
Iron-55	14681-59-5	Short-lived radionuclide (half-life <3 years)
Iron-59	14596-12-4	Short-lived radionuclide (half-life <3 years)
Krypton-85	13983-27-2	Gas, not relevant to liquid waste streams.
Lanthanum-140	13981-28-7	Short-lived radionuclide (half-life <3 years)
Lead-209	14119-30-3	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Lead-210	14255-04-0	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Lead-211	15816-77-0	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Lead-212	15092-94-1	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Lead-214	15067-28-4	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Manganese-54	13966-31-9	Short-lived radionuclide (half-life <3 years)
Neodymium-147	14269-74-0	Short-lived radionuclide (half-life <3 years)
Molybdenum-93	14119-13-2	No apparent source in the 200 Areas (no standard analytical procedure available)
Neptunium-237	13994-20-2	Minimal introduction into the processes involved with this area
Neptunium-238	15766-25-3	Short-lived radionuclide (half-life <3 years)
Neptunium-239	13968-59-7	Short-lived radionuclide (half-life <3 years)
Nickel-59	14336-70-0	Activity will be < 5% of Ni-63 activity
Nickel-63	13981-37-8	Not introduced into processes involved with this area
Niobium-91	N/A	No apparent source in the 200 Areas (no standard analytical procedure available)
Niobium-93m	N/A	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Niobium-94	14681-63-1	No apparent source in the 200 Areas (GEA will report if detected)
Niobium-95	13967-76-5	Short-lived radionuclide (half-life <3 years)
Niobium-96	15832-32-3	Short-lived radionuclide (half-life <3 years)
Niobium-98	15700-41-1	Short-lived radionuclide (half-life <3 years)
Palladium-107	17637-99-9	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Phosphorus-32	14596-37-3	Short-lived radionuclide (half-life <3 years)
Plutonium-238	13981-16-3	
Plutonium-239	15117-48-3	Measurement cannot resolve Pu-239 + Pu-240 isotopes, reported as plutonium-239/240
Plutonium-239/240	PU-239/240	
Plutonium-240	14119-33-6	Measurement cannot resolve Pu-239 + Pu-240 isotopes, reported as plutonium-239/240
Plutonium-241	14119-32-5	Not detected by normal Pu analysis, can infer from Am/Pu results.
Plutonium-242	13982-10-0	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Polonium-210	13981-22-7	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-211	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-212	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-213	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-214	15735-67-8	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-215	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Polonium-216	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Polonium-218	15422-74-9	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Potassium-40	13966-00-2	Naturally occurring isotope not created in Hanford reactor operations.
Praseodymium-143	14981-79-4	Short-lived radionuclide (half-life <3 years)
Praseodymium-144	14119-05-2	Short-lived radionuclide (half-life <3 years)
Promethium-143	14834-72-1	Short-lived radionuclide (half-life <3 years)
Promethium-147	14380-75-7	Short-lived radionuclide (half-life <3 years)
Protactinium-231	14331-85-2	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Protactinium-233	13981-14-1	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Protactinium-234	15100-28-4	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radium-223	15623-45-7	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radium-224	13233-32-4	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radium-225	13981-53-8	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radium-226	13982-63-3	Daughter product that may be calculated from the isotope from which it originates. (GEA will report Ra-226 and Ra-228.)
Radium-228	15262-20-1	Daughter product that may be calculated from the isotope from which it originates. (GEA will report Ra-226 and Ra-228.)
Radon-219	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radon-220	22461-48-7	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Radon-222	14859-67-7	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Rhenium-187	14391-29-8	Naturally occurring isotope not created in Hanford reactor operations.
Rhodium-106	14234-34-5	Short-lived radionuclide (half-life <3 years)
Ruthenium-103	13968-53-1	Short-lived radionuclide (half-life <3 years)
Ruthenium-106	13967-48-1	Short-lived radionuclide (half-life <3 years)
Samarium-147	14392-33-7	Naturally occurring isotope not created in Hanford reactor operations greater than 5E-5 times Cs-137 activity.
Samarium-149		Stable
Samarium-151	15715-94-3	Less than 1% of Cs-137 activity. Insignificant contribution to dose; no standard analytical detection methodology available.
Scandium-46	13967-63-0	Short-lived radionuclide (half-life <3 years)
Selenium-75	14265-71-5	Short-lived radionuclide (half-life <3 years)
Selenium-79	15758-45-9	Constituent generated at less than 5E-5 times Cs-137 activity.
Silver-108	14391-65-2	Short-lived radionuclide (half-life <3 years)
Silver-110m	14391-76-5	Short-lived radionuclide (half-life <3 years)
Sodium-22	13966-32-0	Short-lived radionuclide (half-life <3 years)

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Strontium-85	13967-73-2	Short-lived radionuclide (half-life <3 years)
Strontium-89	14158-27-1	Short-lived radionuclide (half-life <3 years)
Strontium-90	10098-97-2	Routinely analyzed as Total Radioactive Strontium
Total Radioactive Strontium	SR-RAD	
Sulfur-35	15117-53-0	Short-lived radionuclide (half-life <3 years)
Tantalum-182	13982-00-8	Short-lived radionuclide (half-life <3 years)
Technetium-99	14133-76-7	
Tellurium-121	14304-79-1	Short-lived radionuclide (half-life <3 years)
Tellurium-125m	14390-73-9	Short-lived radionuclide (half-life <3 years)
Tellurium-127	13981-49-2	Short-lived radionuclide (half-life <3 years)
Tellurium-129m	14269-71-7	Short-lived radionuclide (half-life <3 years)
Tellurium-129	14269-71-7	Short-lived radionuclide (half-life <3 years)
Thallium-204	13968-51-9	No apparent source in the 200 Areas (no standard analytical procedure available)
Thallium-207	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thallium-208	14913-50-9	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thallium-209	N/A	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thorium-227	15623-47-9	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thorium-228	14274-82-9	Daughter product that may be calculated from the isotopes from which it originates. (Thorium Isotopic - AEA will report this isotope)
Thorium-229	15594-54-4	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thorium-230	14269-63-7	Daughter product that may be calculated from the isotopes from which it originates. (Thorium Isotopic - AEA will report this isotope)
Thorium-231	14932-40-2	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thorium-232	TH-232	Minimal introduction into the processes involved with this area
Thorium-233	N/A	Short-lived radionuclide (half-life <3 years)
Thorium-234	15065-10-8	Daughter product with very low ingrowth relative to the parent, or concentration may be calculated from the isotope from which it originates.
Thulium-170	13981-30-1	Short-lived radionuclide (half-life <3 years)
Tin-113	13966-06-8	Short-lived radionuclide (half-life <3 years)
Tin-123m	14683-07-9	Short-lived radionuclide (half-life <3 years)
Tin-123	14683-07-9	Short-lived radionuclide (half-life <3 years)
Tin-126	15832-50-5	Constituent generated at less than 5E-5 times Cs-137 activity (GEA will report if detected)
Uranium-232	14158-29-3	No apparent source in the 200 Areas (no standard analytical procedure available)
Uranium-233	13968-55-3	Measurement cannot resolve U-233 + U-234 isotopes, reported as U-234 or U-233/234
Uranium-234	13966-29-5	
Uranium-235	15117-96-1	
Uranium-236	13982-70-2	Measurement cannot resolve U-235 + U-236 isotopes, reported as U-235
Uranium-237	14269-75-1	Short-lived radionuclide (half-life <3 years)

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Uranium-238	U-238	
Vanadium-49	14392-01-9	Short-lived radionuclide (half-life <3 years)
Yttrium-88	13982-36-0	Short-lived radionuclide (half-life <3 years)
Yttrium-90	10098-91-6	Short-lived daughter of Sr-90 (which is a final COPC)
Yttrium-91	14234-24-3	Short-lived radionuclide (half-life <3 years)
Zinc-65	13982-39-3	Short-lived radionuclide (half-life <3 years)
Zirconium-93	15751-77-6	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Zirconium-95	13967-71-0	Short-lived radionuclide (half-life <3 years)
Chemicals		
Organics		
VOCs -		
n-Butyl alcohol	71-36-3	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
Kerosene (paraffin hydrocarbons)	8008-20-6	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
2-Propanone (Acetone)	67-64-1	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
2-butanone	78-93-3	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
4-methyl-2-pentanone (Hexone)	108-10-1	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
2-hexanone	591-78-6	Vapor analysis excluded based on USQ 0200W-US-N0144-02, Rev 1
Non-VOCs -		
Tributyl phosphate	126-73-8	
Polychlorinated biphenyls (PCBs)	1336-36-3	
Inorganics		
Cyanide	57-12-5	
Phosphate	14265-44-2	
Nitrate	14797-55-8	
Nitrite	14797-65-0	
Sulfate	14808-79-8	
Chloride	16887-00-6	
Sulfides	18496-25-8	
Metals		
Mercury	7439-97-6	
Lead	7439-92-1	
Nickel	7440-02-0	
Silver	7440-22-4	
Antimony	7440-36-0	
Arsenic	7440-38-2	
Barium	7440-39-3	
Beryllium	7440-41-7	
Cadmium	7440-43-9	
Chromium (total)	7440-47-3	

Table A-1. Hexone Tank COPC List. (7 Pages)

COPC	CAS #	Rationale for Exclusion
Radionuclides		
Copper	7440-50-8	
Selenium	7782-49-2	
Other parameters		
Ignitability	Ignitablty	
pH	pH	
TOC	TOC	
Uranium (total)	7440-61-1	

Table A-2. Hexone Tank COC List, Action Levels, Bases, and Quantitation Limits. (3 Pages)

COC	CAS #	Action Levels and Bases Soil Only		Name/Analytical Technique	Liquids[b] Low Level	Liquids[b] High Level	Solid-Other Low Level	Solid-Other High Level	TRU Threshold
		RR[a]	C/I[a]						
Radionuclides		pCi/g	pCi/g		pCi/L	pCi/L	pCi/g	pCi/g	NA
Americium-241	14596-10-2	*31*	210	Americium Isotopic - Alpha Energy Analysis (AEA)	1	400	1	4000	100 nCi/g
Curium-244	13981-15-2			Curium Isotopic - Alpha Energy Analysis (AEA)	1	400	1	4000	100 nCi/g
Carbon-14	14762-75-5	5.2	33100	Carbon-14 - Liquid Scintillation	200	NA	50	NA	NA
Cesium-137	10045-97-3	6.2	25	Gamma Energy Analysis	15	200	0.1	2000	NA
Cobalt-60	10198-40-0	1.4	5.2	Gamma Energy Analysis	25	200	0.05	2000	NA
Europium-152	14683-23-9	3.3	12	Gamma Energy Analysis	50	200	0.1	2000	NA
Europium-154	15585-10-1	*3*	*11*	Gamma Energy Analysis	50	200	0.1	2000	NA
Europium-155	14391-16-3	*125*	*449*	Gamma Energy Analysis	50	200	0.1	2000	NA
Hydrogen-3	10028-17-8	510	14200	Tritium – Liquid Scintillation	400	400	400	400	NA
Plutonium-238	13981-16-3	*37.4*	*47.3*	Plutonium Isotopic - AEA	1	130	1	1300	100 nCi/g
Plutonium-239/240	PU-239/240	33.9	437	Plutonium Isotopic - AEA	1	130	1	1300	100 nCi/g
Total Radioactive Strontium	SR-RAD			Total Radioactive Strontium - Gas Proportional Counting (GPC)	2	80	1	800	NA
Technetium-99	14133-76-7	5.7	410000	Technetium-99 - Liquid Scintillation	15	400	15	4000	NA
Uranium-234	13966-29-5	160	1200	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	NA
Uranium-235	15117-96-1	26	100	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	NA
Uranium-238	U-238	85	420	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	NA
Chemicals		Meth B	Meth C						
Organics	CAS #	µg/kg	µg/kg		mg/L	mg/L	mg/kg	mg/kg	
n-Butyl alcohol	71-36-3	160000	350000	Non-Halogenated VOA - 8015 – GC	5	NA	5	NA	NA
Kerosene (paraffin hydrocarbons)	8008-20-6	200000	200000	Non-Halogenated VOA - 8015M - GC modified for hydrocarbons	0.5	0.5	5	5	NA

Table A-2. Hexone Tank COC List, Action Levels, Bases, and Quantitation Limits. (3 Pages)

COC	CAS #	Action Levels and Bases Soil Only		Name/Analytical Technique					
		RR[a]	C/I[a]		Liquids[b] Low Level	Liquids[b] High Level	Solid-Other Low Level	Solid-Other High Level	TRU Threshold
2-Propanone (Acetone)	67-64-1	8000000	350000000	Volatile Org. - 8260 - GCMS	0.02	0.02	0.02	0.02	NA
2-butanone	78-93-3	48000000	2100000000	Volatile Org. - 8260 - GCMS	0.01	0.01	0.01	0.01	NA
4-methyl-2-pentanone (Hexone)	108-10-1	6400000	280000000	Volatile Org. - 8260 - GCMS	0.01	0.01	0.01	0.01	NA
2-hexanone	591-78-6	none	none	Volatile Org. - 8260- GCMS	0.02	0.02	0.02	0.02	NA
Tributyl phosphate	126-73-8	none	none	Semi-Volatiles - 8270 - GCMS	0.1	0.5	3.3	10	NA
Polychlorinated biphenyls (PCBs)	1336-36-3	500	65000	PCBs – 8082[c] - GC	0.0005	0.005	0.0165	0.1	NA
Inorganics									
Cyanide	57-12-5	1600000	70000000	Total Cyanide - 9010 – Colorimetric	0.005	0.005	0.5	0.5	NA
Phosphate	14265-44-2	N/A	N/A	Anions – 300.0- IC	0.5	15	5	40	NA
Nitrate	14797-55-8	4400000	4400000	Anions – 300.0 - IC	0.25	10	2.5	40	NA
Nitrite	14797-65-0	330000	330000	Anions – 300.0 - IC	0.25	15	2.5	20	NA
Sulfate	14808-79-8	25000000	25000000	Anions – 300.0 - IC	0.5	15	5	40	NA
Chloride	16887-00-6	25000000	25000000	Anions – 300.0 - IC	0.2	5	2	5	NA
Sulfides	18496-25-8	N/A	N/A	Sulfide – 9030 - Colorimetric	0.5	NA	5	NA	NA
Metals									
Mercury	7439-97-6	24000	96000	Mercury - 7471 - CVAA	NA	NA	0.2	0.2	NA
Lead	7439-92-1	353000	353000	Metals – 6010 - ICP	0.1	0.2	10	20	NA
Nickel	7440-02-0	1600000	70000000	Metals – 6010 - ICP	0.04	0.04	4	4	NA
Silver	7440-22-4	400000	1600000	Metals – 6010 - ICP	0.02	0.02	2	2	NA
Antimony	7440-36-0	32000	1400000	Metals – 6010 - ICP	0.06	0.12	6	12	NA
Arsenic	7440-38-2	1670	219000	Metals – 6010 - ICP	0.1	0.2	10	20	NA
Barium	7440-39-3	132000	245000	Metals – 6010 - ICP	0.2	0.2	20	20	NA
Beryllium	7440-41-7	233	30500	Metals – 6010 - ICP	0.005	0.01	0.5	1	NA
Cadmium	7440-43-9	80000	3500000	Metals – 6010 - ICP	0.005	0.01	0.5	1	NA
Chromium (total)	7440-47-3	1600000	3500000	Metals – 6010 - ICP	0.01	0.01	1	2	NA
Copper	7440-50-8	59200	130000	Metals – 6010 - ICP	0.025	0.025	2.5	2.5	NA
Selenium	7782-49-2	5000	5000	Metals – 6010 - ICP	0.1	0.2	10	20	NA

Table A-2. Hexone Tank COC List, Action Levels, Bases, and Quantitation Limits. (3 Pages)

COC	CAS #	Action Levels and Bases Soil Only		Name/Analytical Technique					
		RR[a]	C/I[a]		Liquids[b] Low Level	Liquids[b] High Level	Solid-Other Low Level	Solid-Other High Level	TRU Threshold
Lead	7439-92-1	353000	353000	Metals – 6010 - ICP(TRACE)	0.01	NA	1	NA	NA
Silver	7440-22-4	8000	10000	Metals – 6010 - ICP(TRACE)	0.005	NA	0.5	NA	NA
Antimony	7440-36-0	32000	1400000	Metals – 6010 - ICP(TRACE)	0.01	NA	1	NA	NA
Arsenic	7440-38-2	6500	6500	Metals – 6010 - ICP(TRACE)	0.01	NA	1	NA	NA
Barium	7440-39-3	132000	245000	Metals – 6010 - ICP(TRACE)	0.005	NA	0.5	NA	NA
Cadmium	7440-43-9	500	500	Metals – 6010 - ICP(TRACE)	0.005	NA	0.5	NA	NA
Chromium (total)	7440-47-3	1600000	3500000	Metals – 6010 - ICP(TRACE)	0.01	NA	1	NA	NA
Uranium (total)	7440-61-1	240000	10500000	Uranium Total - Kinetic Phosphorescence Analysis	0.0001	0.02	1	0.2	NA
Selenium	7782-49-2	400000	1600000	Metals – 6010 - ICP(TRACE)	0.01	NA	1	NA	NA
Lead	7439-92-1	353000	353000	TCLP Metals by ICP - 1311/6010	5,000	5,000	as extract	as extract	NA
Silver	7440-22-4	8000	10000	TCLP Metals by ICP - 1311/6010	5,000	5,000	as extract	as extract	NA
Arsenic	7440-38-2	6500	6500	TCLP Metals by ICP - 1311/6010	5,000	5,000	as extract	as extract	NA
Barium	7440-39-3	132000	245000	TCLP Metals by ICP - 1311/6010	100,000	100,000	as extract	as extract	NA
Cadmium	7440-43-9	500	500	TCLP Metals by ICP - 1311/6010	1,000	1,000	as extract	as extract	NA
Chromium (total)	7440-47-3	1600000	3500000	TCLP Metals by ICP - 1311/6010	5,000	5,000	as extract	as extract	NA
Selenium	7782-49-2	400000	1600000	TCLP Metals by ICP - 1311/6010	1,000	1,000	as extract	as extract	NA
Other parameters									
Ignitability	Ignitability			Ignitability - 1020	NA	NA	NA	NA	NA
pH	pH	N/A	N/A	pH - 9045 - Electrode	NA	NA	NA	NA	NA
TOC	TOC			TOC-9060	1,000	1,000	25,000	25,000	NA

[a] RR =Rural Residential; C/I – Commercial Industrial. Values from Washington Department of Health (WDOH) *Hanford Guidance for Radiological Cleanup*, WDOH/320-015.

Italicized values are calculated using the same parameters as the WDOH guidance.

[b] Water values for sampling QC (e.g., equipment blanks/rinses) or drainable liquid (if recovered).

[c] All four-digit numbers refer to *Test Methods for Evaluating Solid Waste* (EPA SW-846).

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