KBC-31475
Revision 0

Data Quality Objectives Summary Report for the 105 K East Basin Ion Exchange Column Monolith

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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TERMS

ALARA	as low as reasonably achievable
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*U.S. Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CWC	Central Waste Complex
D&D	deactivation and decommissioning
DQO	data quality objective
DR	decision rule
DS	decision statement
EFSH	Energy Solutions Federal Services, Hanford
ERDF	Environmental Restoration Disposal Facility
EPA	U.S. Environmental Protection Agency
FH	Fluor Hanford, Inc.
IX	Ion Exchange
IXC	Ion Exchange Column
IXM	Ion Exchange Module
KBC	K Basins Closure
KE	105-K East (Basin)
KW	105-K West (Basin)
LDR	Land Disposal Restricted
LLBG	low-level burial grounds
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
PSQ	principal study question
QA	quality assurance
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	Record of Decision
SNF	spent nuclear fuel
SWOC	Solid Waste Operations Complex
TC	toxic characteristic
TCLP	toxicity characteristic leaching procedure
TRU	transuranic
TSCA	*Toxic Substance Control Act of 1976*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*
WCH	Washington Closure Hanford, LLC
WIPP	Waste Isolation Pilot Plant

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1.0 INTRODUCTION

The 105-K East (KE) Basin Ion Exchange Column (IXC) cells, lead caves, and the surrounding vault are to be removed as necessary components in implementing *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 2003) milestone M-034-32 (Complete Removal of the K East Basin Structure). The IXCs consist of six units located in the KE Basin, three in operating positions in cells and three stored in a lead cave.

Methods to remove the IXCs from the KE Basin were evaluated in KBC-28343, *Disposal of K East Basin Ion Exchange Column Evaluation*. The method selected for removal was grouting of the six IXCs into a single monolith for disposal at the Environmental Restoration Disposal Facility (ERDF). Grout will be added to the IXC cells, IXC lead caves containing spent IXCs, and in the spaces between to immobilize the contaminants, provide self-shielding, minimize void space, and provide a structurally stable waste form. The waste to be offered for disposal is the encapsulated monolith defined by the exterior surfaces of the vault and the lower surface of the underlying slab.

The IXC monolith must be characterized and prepared for disposal per the *Declaration of the Record of Decision for DOE Hanford 100 Area, 100-KR-2 Operable Unit* [EPA 1999], and removed by the *Interim Action Record of Decision for the 100-BC-I, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-I, 100-HR-2, 100-KR-I, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (also known as the "100 Area Remaining Sites ROD" [EPA 1999]) for the K Basins interim remedial action. Characterization data will be evaluated relative to BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria,* or other applicable requirements. If the IXC monolith does not comply with BHI-00139, then the waste will be disposed at another waste management facility, such as the Hanford low-level burial ground (LLBG), as approved by the U.S. Environmental Protection Agency (EPA). The purpose of this document is to specify the data, data quality control, and data management necessary to dispose of the IXC monolith as low-level waste at the ERDF, or if not ERDF-compliant, then another facility approved by the EPA.

This document presents a summary of the data quality objective (DQO) process establishing the decisions and data required to support decision-making activities for disposition of the IXC monolith. The DQO process is completed in accordance with the seven-step planning process described in EPA QA/G-4, *Guidance for the Data Quality Objectives Process,* which is used to clarify and study objectives; define the appropriate type, quantity, and quality of data; and support defensible decision-- making. The DQO process involves the following steps.

1. State the problem.
2. Identify the decision.
3. Identify the inputs to the decision.
4. Define the boundaries of the study.
5. Develop a decision rule (DR).
6. Specify tolerable limits on decision errors.
7. Optimize the design for obtaining data.

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2.0 DQO PROCESS

2.1 STEP 1—STATE THE PROBLEM

2.1.1 Identify the Planning Team Members and Decision Makers

The DQO planning team is usually composed of the project manager, technical staff, data users, and stakeholders.

Table 2-1 shows the planning team assembled to contribute to the DQO process for the IXC monolith, based on the recommendations of the project lead and decision makers. Table 2-2 shows the key decision makers.

Table 2-1. Data Quality Objective Planning Team for the Ion Exchange Column Monolith.

Name	Company/organization	Position or area of expertise
Darrin Faulk	FH/Quality Assurance	Environmental QA
Mary Ann Green	FH/KBC D&D Work Management	D&D Technical Point of Contact
Gary Hastings	FH/KBC Radiological Control	Radiological Specialist
Rod Jochen	FH/100K Facility Operations	Sample Management/Waste Management
Rich Lipinski	WCH/Waste Services	Waste Management
George Mata	FH/KBC Quality Assurance	Quality Assurance
Dan Moder	FH/Closure Projects	KE Waste Management
Tom Orgill	EFSH/KBC D&D Work Management	D&D Project Manager
Tino Romano	FH/Transportation Safety Operations	Transportation Specialist
Jim Sailer	Xron Associates, Inc.	Environmental Compliance
Glen Triner	EFSH/KBC Waste Management	Manager, Waste Management
Dave Watson	FH/KBC Environmental	Environmental Compliance Officer
Jeff Westcott	FH/SWOC Projects	Waste Management
Chuck White	FH/KBC Waste Management	KW Waste Management
Terry Winward	FH/KBC Environmental	Regulatory Support

D&D = deactivation and decommissioning.
EFSH = Energy Solutions Federal Services, Hanford.
FH = Fluor Hanford, Inc.
KBC = K Basins Closure.
KE = K East.
KW = K West.
QA = quality assurance.
SWOC = Solid Waste Operations Complex.
WCH = Washington Closure Hanford, LLC.

Table 2-2. Key Decision Makers for the Ion Exchange Column Monolith Data Quality Objectives.

Name	Organization
Ellen Dagan	U.S. Department of Energy, Richland Operations Office
Larry Gadbois	U.S. Environmental Protection Agency

2.1.2 Describe the Problem and Establish a Conceptual Model

2.1.2.1 Problem Statement

The problem statement is intended to describe the conditions or circumstances that are causing a problem and the reasons for undertaking the study, such as potential hazards or regulatory compliance issues.

The problem statement specific to the K Basins Closure (KBC) IXC monolith is as follows.

"The KBC IXC monolith must be prepared and characterized for compliant disposal at ERDF or other EPA-authorized facility."

The DQOs are developed based on the following assumptions.

- Ion columns exhibit extremely high dose rates, which prohibit removal of individual ion columns. Most of the source for the radiological characterization is inside the individual ion columns. The contamination in associated piping and the internal surfaces of the caves and cells is significant but small compared to the resin beads contained in each IXC.

- There are no chemical hazardous constituents in the final waste form except the lead cave, polychlorinated biphenyl (PCB) and toxic characteristic (TC) metals. The chemical hazardous constituents will be considered macroencapsulated once the grout is cured in the monolith and meets Land Disposal Restricted (LDR) standards.

- The IXC monolith will either comply with BHI-00139 or be treated to comply with BHI-00139, and will be disposed of at the ERDF. If the IXC monolith cannot be sent to the ERDF, it will be sent to another Hanford Site waste management facility.

- Packaging for transportation or disposal beyond the grouting will be minimal, but may include use of fixatives, plastic sheeting, and shielding as necessary.

- The radiological characterization of the monolith is based solely on the IXCs as the large inventory overwhelms other possible contributions. The radionuclide inventories for the IXCs are calculated for Cs-137, Sr-90 Pu-238, and Pu-239 by subtracting the outlet concentration from the inlet concentration to determine the concentration captured on the

IXC, then multiplying by the flow rate, and time in service. The activities of other isotopes calculated were similarly based upon the method presented in Section 2.3 of HNF-6495, *Sampling and Analysis Plan for K Basins Debris*, Revision 1, for characterization of Ion Exchange Module (IXM) units, but any isotope with an atomic weight greater than 210 was scaled from Pu-239. The concentration will be averaged over the mass and volume of the grouted vessel plus the lower portion of the surrounding grouted vault, with the exception of half the cave and the 1 ft outside layer of the exterior of the monolith for purposes of radioactive waste classification determination. Grout added to the cavity of the cells and cave will incorporate and bind any residual contaminants, minimize void space, provide shielding consistent with as low as reasonably achievable (ALARA) principles, and provide compliant waste form in accordance with transportation and BHI-00139 requirements.

- Based on HNF-27474 (Draft), *One-Time Request for Shipment 105-KE Monoliths*, the IXCs are not filled with grout, as are the vessels in the other monolith packages, a shipping time limit was determined to preclude flammable gas concentrations. A hydrogen generation rate of 0.274 cm^3/h within the bounding -KE IXC was calculated, and a shipping time limit of 417 days was conservatively determined. The shipping time limit starts when grouting begins and ends when the monolith arrives at the onsite storage/disposal facility. No gas generation analysis is performed for accident conditions for the nonequivalent package. The solid waste form intrinsically precludes propagation of a detonation. The time limit of 417 days is not only a transportation time limit, but also a waste disposal time limit. Time needs to be available at the disposal facility to place the waste in the disposal cell before possible hydrogen generation could create a flammable atmosphere in the IXC monolith.

2.1.2.2 Conceptual Model

The conceptual model identifies known or expected locations of contaminants, potential sources of contaminants, media that are contaminated or may become contaminated, and exposure scenarios.

The KE Basin is located in the 100 K Area on the Hanford Site. The KE Basin is a 4.9 million L (1.3 million gal), open-topped concrete pool constructed in the early 1950s to store spent nuclear fuel (SNF) from the KE Reactor, which was removed from service in the early 1970s. SNF, primarily from the N Reactor, was stored in the KE Basin beginning in 1975 (DOE/EIS-0245, *Environmental Impact Statement-Management of Spent Nuclear Fuel from the K Basins at the Hanford Site*). Fuel was stored in canisters arranged in metal racks on the floor of the basin with a water cover to a depth of approximately 6.1 m (20 ft). Fuel stored in the basin has since fractured or corroded, releasing soluble materials, particulates, and fuel pieces, which, combined with dust and other debris, accumulate as sludge on the basin floor.

The water recirculation equipment (termed the "main recirculation loop" or the "primary recirculation loop") processed approximately 9 L/s (150 gal/min) of water through each of the basin's three bays via suction and discharge headers located about 2 m below the pool's surface. By 1981, the KE Basin was reactivated and three IXCs were added to the loop. Each IXC contains 142 L (5 ft^3) of strong acid cation/strong base anion, organic ion exchange (IX) resin, and Duolite or Purolite (mixed bed resin). The three IXCs were operated in parallel in order to provide the necessary water processing flow rate. IXCs were used during the period from 1981 through 1993 to maintain the water quality in the basins. The columns were drained after use in February 1993. IXCs are no longer in service at the KE Basin because of the high radiation exposure during handling. There are no plans to generate additional IXCs. Figure 2-1 shows a basic piping diagram depicting the KE Basin water-cooling and cleanup system.

A thorough characterization of the IXC monolith will be developed prior to placing grout in the cells, caves, and surrounding vault. The final characterization will be compared to the characterization requirements of BHI-00139 for compliance prior to grouting the monolith.

Grout will be pumped into the cells, caves, and the surrounding vault. The grout will immobilize contaminants, minimize interior void, provide self-shielding, and provide a structurally stable waste form. The entire IXC monolith will be removed along with other monoliths from the KE Basin. The waste to be offered for disposal is the entire monolith package consisting of the three cells, lead cave, cement slab under the cells, and grout inside and outside the cells and cave.

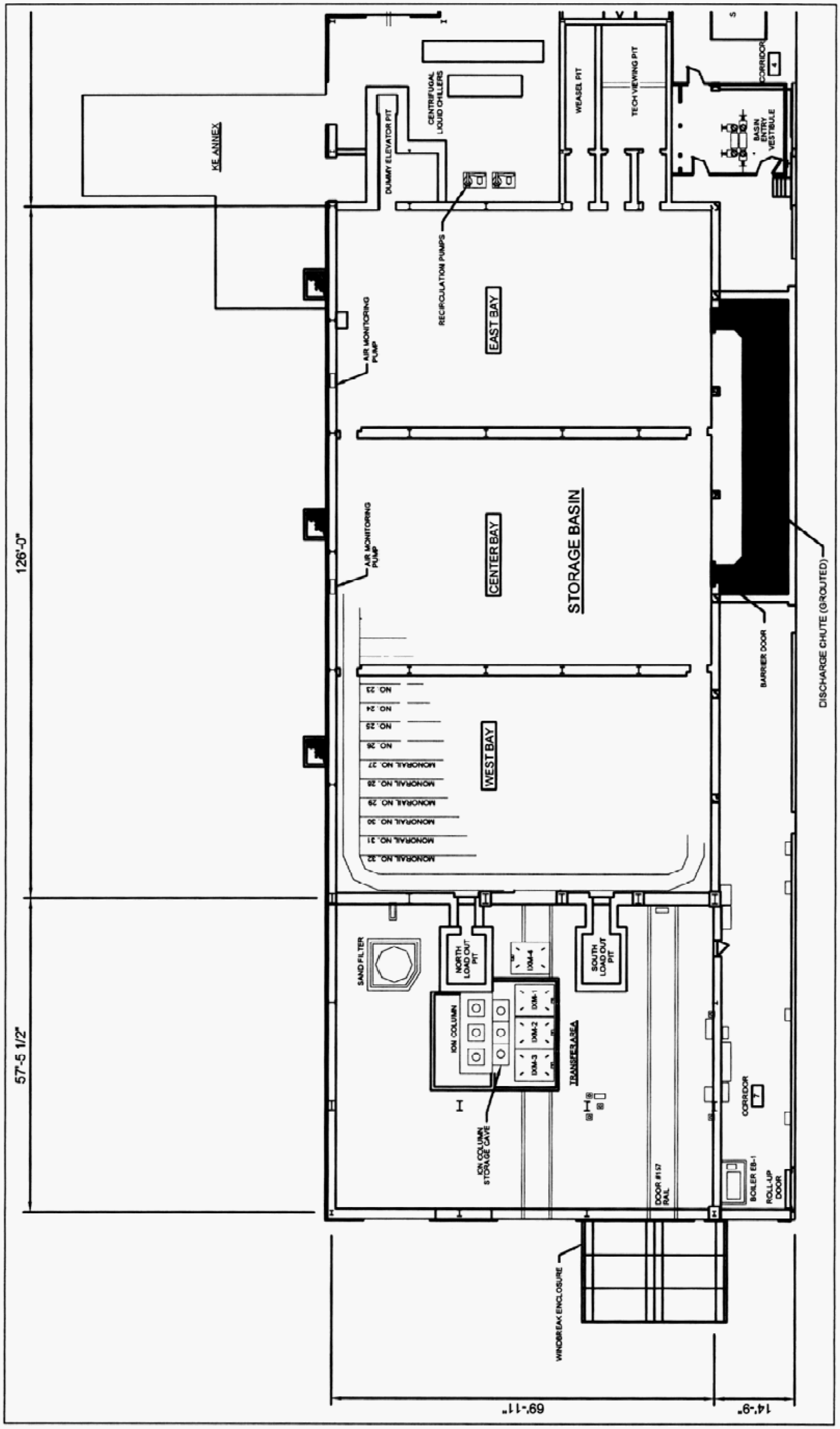


Figure 2-1. 105-K East Basin Structure.

Table 2-3 presents estimates of the constituents, volumes, and weights associated with the monolith waste form based on 150 lb/ft^3 density structural concrete and 105 lb/ft^3 density grout being added. The monolith is estimated to measure approximately 10 ft 6 in. wide, 17 ft long, and 12 ft high and weigh 279,291 lb. The total ungrouted void space of the monolith containing the six IXCs is conservatively estimated to total 18 ft^3 (i.e., approximately 1,050 gal).

Table 2-3. Estimated Total Monolith Gross Volume and Weight Information.[1]

Component	Volume (ft^3)	Weight (lb)
IXCs and associated components	4.8	2,116
6-IXCs[2]	4	1,920
Associated piping	0.8	196
Concrete cells 6 ft W x 15 ft L x 10 ft-1 in. H	964.6	145,000
Lead caves 165 ft L x 30 ft W x 72 ft H	27.8	18,360
Steel skin	5.5	1,339
Lead shielding	21.9	7,740
Steel frame	0.4	98
Concrete floor 10ft-6in. W x 17 ft L x 1 ft D	178	26,775
Monolith form (1 ft larger in every dimension)	488	4,904
Steel skin (¼-in. steel plate)	7	3,370
Structural ribs	481	1,534
Grout	782.3	82,136
Total monolith	2,446	279,291

[1]The volumes and weights associated with this table were calculated using drawings H-1-34789, H-1-34834, H-1-34837, H-1-45071, and H-1-21072. A specific calculation was performed by engineering on 4/28/05. Some numbers were rounded when placed in this table.
[2]The volume of IXCs shown here is not the total vessel volume of 8 ft^3 but the volume of resin inside the vessels of 4 ft^3. It is expected that grout will fill the empty 4 ft^3 inside of the IXCs.

IXC = Ion Exchange Column.

Table 2-4. Monolith Volume and Weight Deductions for Waste Classification.

Component	Volume (ft^3)	Weight (lb)
Half of lead caves 165 in. L x 30 in. W x 72 in. H[1]	13.9	9,180
Monolith form (1 ft larger in every dimension)	488	4,904
Half of lead cave grout	103.2	10,814
Total weight being subtracted from total monolith weight for waste classification	605	24,898

[1]The use of half the lead cave weight and half the grout weight in the caves was because only three IXCs are stored in the caves, when the caves could hold up to six IXCs in storage.

IXC = Ion Exchange Column.

Table 2-3 calculates the total weight and volume of the monolith containing the IXCs. Table 2-4 calculates the weight and volume of the IXC-containing monolith that is not appropriate to consider for determining the concentration of radionuclides in accordance with the Branch Technical Position (BTP) *Issuance of final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position* (NRC 1995). These weight and volume deductions consist of the external concrete layer placed around the cave and cells for structural purposes and half of the lead caves because the lead cave is only half-full of IXCs. The waste volume and mass that is appropriate to average the concentration of radionuclides contained in the monolith for determination of radioactive waste class is the total values shown in Table 2-3 less the total values shown in Table 2-4, which is 1,841 ft^3 and 254,393 lb (Appendix A).

The source of contamination in the IXCs is primarily radionuclides released from corroded SNF stored in the KE Basin. Because the IXC monolith is similar to the IXM, the designation approach is similar. As reported in HNF-6495, the IXC monolith will be regulated by the *Toxic Substance Control Act of 1976* (TSCA) for PCBs. TC metals are also a concern.

Contaminants of concern (COC) are radiological or chemical substances that are the focus of an evaluation based on regulatory criteria or health concerns. The final list of COCs is identified using the following process of elimination.

1. Compile a list of all contaminants of potential concern (COPC) based on acceptable process knowledge of components of the IXC monolith.

2. Eliminate COPCs for which process knowledge and/or analytical data are sufficient to confirm that they are not present or are not reasonably expected to be in the waste stream.

3. Eliminate chemical COPCs with negligible concentrations and that are far below regulatory limits.

4. Eliminate radionuclide COPC when they are naturally occurring or may be shown to be less than the disposal facility reporting limit.

COPCs not specifically eliminated through the steps described above become the COCs.

2.1.2.2.1 Contaminants of Potential Concern

Table 2-5 identifies the COPCs for the IXC monolith.

Table 2-5. Contaminants of Potential Concern for Ion Exchange Column Monolith.

Contaminant Source	Type of Contamination (general)	Contaminants of Potential Concern (specific)
Spent fuel in basin	Radionuclides	Radionuclides[a]
Basin water	Radionuclides (from spent fuel), metals, PCB	Radionuclides[a], As, Ba, Cd, Cr, Pb, Hg, Se, Ag, PCB
Equipment located in the basin	Hydraulic fluid	Polyalkanes
IXC columns (less media), cells, lead caves, piping and instruments	Stainless steel, carbon steel, structural concrete, aggregate, metals	Fe with small quantities of C, N, Si, P, S, CR, Mn, Ni, Mo; Ca, Si, Al, and Fe oxides; Pb
IXC media	Resin	$C_{10}H_{12}$, $C_{10}H_{10}$,C_8H_8; $C_{10}H_{12}$, $C_{10}H_{10}$,C_8H_8, C_3H_9N (Purolite NRW-37)
Grout	Silica sand, metal oxides	pH, SiO_2, Al_2O_3, Fe_2O_3, MgO, and CaO

[a]HNF-SD-SNF-TI-015, 2001, *Spent Nuclear Fuel Project Technical Databook*, Rev. 7, Fluor Hanford, Inc., Richland, Washington. (Table 4-12b.)

IXC = Ion Exchange Column.
PCB – polychlorinated biphenyl.

2.1.2.2.2 Contaminants of Potential Concern Exclusions

Table 2-6 shows the COPCs to be excluded from the investigation and the rationale for these exclusions.

Table 2-6. Excluded Contaminants of Potential Concern for the Ion Exchange Column Monolith. (2 sheets)

Contaminant Source	Contaminants of Potential Concern	Rationale for Exclusion
Spent fuel Basin water	Cr-51, Mn-54, Sr-89, Nb-95, Nb-95m, Zr-95, Ru-106, Rh-106, Pd-107, Ag-110, Ag-110m, In-113, Sn-113 Sn-119m, Sn121m, Sn-123, Te-123m, Sb-124, Sb-126, Te-126m, Sb-126m, Te-127, Te-127m, Te-129, Te-129m, Ce-144, Pr-144, Pr-144m, Gd-153, Tb-160, Am242, Cm-242	Nuclides removed for consideration because half-lives are less than two years (see Appendix B).
	Kr-85	Element exists as a gas, which will not be retained in the water.
	I-129	Upper bound estimate of possible radionuclide content (see Appendix B) is less than 1 pCi/g of waste, which is not reportable (BHI-00139).

Table 2-6. Excluded Contaminants of Potential Concern for the Ion Exchange Column Monolith. (2 sheets)

Contaminant Source	Contaminants of Potential Concern	Rationale for Exclusion
Equipment	Polyalkane hydraulic fluids	The IXCs were on the primary system; the suction for the primary system was under water. The specific gravity of hydraulic fluid is less than that of basin water. The hydraulic fluid would therefore stay on top of the basin water. Because the skimmer system draws suction from near surface, the skimmer system would have cleaned any hydraulic fluid from the surface.
IXC cells and storage caves	C, N, Si, P, S, CR, Mn, Ni, Mo; Ca, Si, Al, and Fe oxides	Steel and concrete matrices are not regulated under RCRA.
Resin	$C_{10}H_{12}$, $C_{10}H_{10}$,C_8H_8; $C_{10}H_{12}$, $C_{10}H_{10}$,C_8H_8, C_3H_9N	IX resin is non-hazardous.
Grout	SiO_2, Al_2O_3, Fe_2O_3, MgO, and CaO	The grout is unregulated material after it is cured.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

KBC-28343, 2006, *Disposal of K Basin Ion Exchange Column Evaluation*, Rev.1, Fluor Hanford, Inc., Richland, Washington.

Resource Conservation and Recovery and Conservation Act of 1976, 42 USC 6901 et seq.

ERDF = Environmental Restoration Disposal Facility.
IX Ion Exchange.
IXC = Ion Exchange Column.
RCRA = Resource Recovery and Conservation Act of 1976.

2.1.2.2.3 Constituents of Concern List

Table 2-7 shows the final COCs.

Table 2-7. Final List of Contaminants of Concern for the Ion Exchange Column Monolith.

Radionuclides	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Zr-93, , Nb-93m, Tc-99, Cd-113m, Sb-125, Sn-126, Cs-134, Sc-135, Cs-137, Pm-147, Sm-151, Eu-152, Eu-154, Eu-155, U-234, U-235, U-236, U-238, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am241, Am-242m, Am-243, and Cm-244.
Metals	Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.
Organics	Polychlorinated biphenyl.
Physical characteristics	Void space, pH.

Because the IXCs are similar to the IXMs, which contain the same resin and are generated in the KE basin, the same chemical designation methodology will be used. HNF-6495 concludes that the basin water that runs through an IXM is not a dangerous waste under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." The radionuclide content of the IXM was estimated from analysis of basin water and an assumption that the IXM removes 100% of the radionuclides, except tritium, measured in the water. TC metals are analyzed for and that data is used. The potential content of PCBs and toxic metals that may sorb onto the IX resins was conservatively estimated based on the COCs being present in basin water at concentrations detected and reported. IXMs are TSCA regulated and are considered PCB remediated waste.

The IXCs are similar to the columns in an IXM. The resin media is the same, and would therefore interact with the water in the same manner. The IXC resin would be designated as TSCA regulated. The IXC will be grouted in place as a monolith. The resin, which has cross-linked into a solid block (KBC-28343), is potentially regulated for TC metals. Therefore, if treatment is required for TC metals, the grouting will meet 40 CFR 268.45, "Treatment standards for hazardous debris," alternative treatment standards for hazardous debris via macroencapsulation.

The IXC monolith will contain a lead cave holding three IXCs. The lead cave will be designated as a D008 for radioactive lead solids and the concrete will encapsulate and treat the lead.

The IXC monolith is expected to have void spaces. The three IXCs will be unhooked from all hoses while in the cells (when the system was taken out-of-service, the IXCs were drained but were not unhooked from the system), and all cell and lead cave access ports will be removed. Because there is no way to ensure that grout flows into the IXC column itself, the IXC monolith will exhibit void spaces that will meet the ERDF Acceptance Criteria through structural stabilization of the IXC monolith itself. However, because the waste will be fully encapsulated with grout and the IXC is a pressure vessel to withstand a pressure of 125 lb/in^2, the waste form would prevent possible future subsidence.

Existing radionuclide analytical data and process knowledge are adequate to establish an estimate of nuclide concentrations in the IXC monolith resin as detailed in Appendix B.

2.1.3 Determine the Resources

The evaluation of resources identifies limitations on resources and time constraints for collecting data. Removal of the IXC monolith is a necessary component in implementing milestone M-034-32. Removal of the IXC monolith may begin in the second quarter of fiscal year 2007. The IXC cells and caves are expected to exhibit a high radiation dose in and around them. Work associated with the removal of the IXC shall be performed in a manner consistent with ALARA principles.

Specific resources related to this activity will be established separately.

2.2 STEP 2—IDENTIFY THE DECISION

2.2.1 Identify the Principal Study Question

Based on a review of the problem, the principal study questions (PSQ) are identified as specifically as possible to focus the search for information required to address the problem. The PSQ identifies key unknown conditions or unresolved issues and typically is stated relative to regulatory criteria. The EPA recommends that only one PSQ be identified initially; others may be added later.

The PSQ for the IXC monolith is as follows.

Does the IXC monolith meet the requirements for disposal at the ERDF as identified in BHI-00139. The PSQs, alternative actions, and decision statements (DS) are applicable to the IXC monolith as presented in Table 2-8.

2.2.2 Define Alternative Actions

Alternative actions are possible actions that may be taken to solve a problem, including an alternative that requires no action. The team should confirm that the alternative actions could resolve the problem and determine whether the actions satisfy regulations.

Alternative actions for disposition of the IXC monolith are as follows

- Dispose of the IXC monolith at the LLBG.
- Dispose of the IXC monolith at the Waste Isolation Pilot Plant.
- Take no action.

2.2.3 Develop a Decision Statement

After examining the alternative actions, the PSQ and the alternative actions are combined into a DS that expresses a choice among alternatives.

The no-action alternative does not support milestone M-034-32 and is therefore unacceptable. Table 2-8 shows PSQs, alternative actions, and DSs relevant to disposition of the waste based on the results of waste characterization.

2.2.4 Organize Multiple Decisions

If multiple decisions relate to each other, the decisions should be prioritized and organized sequentially to the extent possible.

Figure 2-2 shows the hierarchy of decisions relevant to disposition of the waste.

2.3 STEP 3—IDENTIFY THE INPUTS TO THE DECISION

Step 3 involves identifying the kind of information that is needed to resolve the DS and the potential sources of this information (i.e., new or existing data). The information should include the decision values (e.g., concentration of contaminants), how the decision values are established, and appropriate methodologies to measure characteristics.

Table 2-8. Principal Study Questions, Alternative Actions, and Decision Statements. (3 sheets)

	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ-AA#	**#1—Does the radiological activity of the IXC Monolith exceed the TRU classification limits and is TRU waste?**		
1-1	The IXC monolith activity is above the TRU classification and will be managed for disposal at national repository.	The IXC monolith is erroneously determined to be TRU and will be sent through the TRU program certification process.	Not severe. TRU program certification activities will perform additional characterization to make a final TRU determination.
1-2	The IXC monolith waste activity is below the TRU classification limits and will be evaluated for treatment and subsequent disposal at the ERDF.	The IXC monolith is erroneously determined to be LLW and is evaluated for disposal at the ERDF.	Potentially severe. TRU waste could be disposed of at the ERDF that may result in potentially severe impacts to human health and the environment.
DS#	*#1—Determine whether or not the IXC monolith exceeds classification limits and is TRU waste.*		
PSQ-AA#	**#2—Does the IXC monolith designate as dangerous/hazardous wastes?**		
2-1	The IXC monolith contents do not include dangerous/hazardous waste.	The IXC monolith is erroneously determined to be free of dangerous/hazardous wastes.	Slightly severe. The IXC monolith would be disposed as LLW and macroencapsulated so there would be slight severe impact to administrative requirements.
2-2	The IXC monolith contents include dangerous/hazardous waste. The radioactive solid waste will be evaluated for treatment and subsequent disposal at the ERDF.	The IXC monolith is erroneously determined to contain dangerous/hazardous wastes.	Not severe. IXC monolith would be treated and disposed in an approved disposal facility, which has minor cost impact, but no impact to human health or the environment.
DS #	*#2—Determine whether or the not the IXC monolith can be designated as dangerous/hazardous wastes.*		
PSQ-AA#	**#3—If dangerous waste, then is the IXC monolith LDR?**		
3-1	The IXC monolith is determined to be LDR under WAC 173-303-140 and is managed accordingly.	The IXC monolith is erroneously determined to be LDR under WAC 173-303-140 when it is not causing some unnecessary waste treatment.	Not severe. IXC monolith would be treated when it does not have to be. No impact to human health or the environment; however, the cost and schedule to treat the waste may be adversely impacted.

Table 2-8. Principal Study Questions, Alternative Actions, and Decision Statements. (3 sheets)

	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
3-2	The IXC monolith is determined to not be LDR under WAC 173-303-140 and it is managed accordingly.	The IXC monolith is erroneously determined not to be LDR under WAC 173-303-140 when it is. The waste may not be treated to comply with LDR when it should be.	Slightly severe. IXC monolith that requires treatment for safe disposal would already be treated by macroencapsulation, but slight impact to administrative requirements.
DS #	*#3—Determine whether or the not the IXC monolith determined to be dangerous/hazardous waste are LDR.*		
PSQ-AA#	**#4 – Does the IXC monolith contain PCB requiring management?**		
4-1	The IXC monolith is determined not to contain PCB requiring management.	The IXC monolith is erroneously determined to not contain PCB requiring management.	Not severe. The ERDF can dispose of PCB-containing waste at unlimited concentration as long as the waste is solid form. Liquid must be removed from the waste for it to be compliant for disposal at the ERDF so only LLSW in solid form will be disposed.
4-2	The IXC monolith is determined to contain PCB requiring management.	The IXC monolith is erroneously determined to contain PCB requiring management.	Not severe. IXC monolith would require management possibly including treatment for the PCB content that is not necessary. The potential impact includes additional cost and personnel exposure to the waste, but no impact to human health and the environment.
DS #	*#4—Determine whether or the not the IXC monolith contains PCB requiring management.*		
PSQ-AA#	**#5—Does the IXC monolith comply with the ERDF WAC (e.g., waste exceeding the NRC Class C limits)?**		
5-1	The IXC monolith is determined not to comply with the ERDF WAC.	The IXC monolith is erroneously determined not to comply with the ERDF WAC.	Not severe. Non-restricted wastes would be treated and disposed in an approved disposal facility, which has a cost and schedule impact, but no impact to human health or the environment.
5-2	The IXC monolith is determined to comply with the ERDF WAC.	The IXC monolith is erroneously determined to comply with the ERDF WAC.	Potentially severe. Waste is inappropriately disposed in the ERDF that could pose a threat to human health or the environment.
DS#	*#5 - Determine whether or the not the IXC monolith contents are compliant with ERDF WAC for disposal.*		

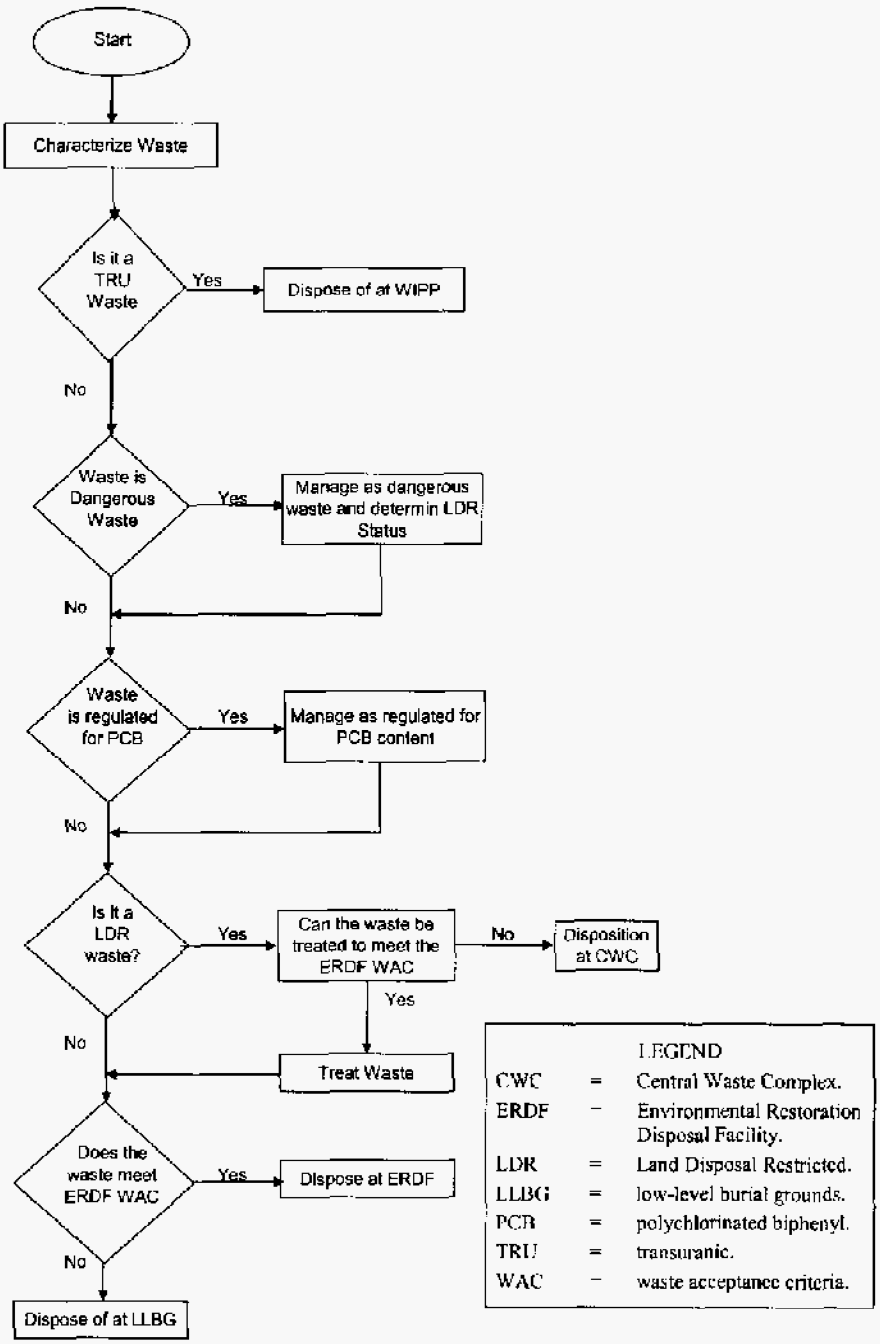
Table 2-8. Principal Study Questions, Alternative Actions, and Decision Statements. (3 sheets)

	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences

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

AA = alternative action.
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
IXC = Ion Exchange Column.
LDR = Land Disposal Restricted.
LLSW = low-level solid waste.
LLW = low-level waste.
NRC = U.S. Nuclear Regulatory Commission.
PCB = polychlorinated biphenyl.
PSQ = principal study question.
TRU = transuranic.
WAC = waste acceptance criteria.

Figure 2-2. Ion Exchange Column Monolith Disposition Logic Diagram.



2.3.1 Identify the Information Needed

Information needs may include physical, chemical, or radiological characteristics of the media being evaluated; whether existing data is useable; and whether new measurements are required.

Table 2-7 shows the information needs for the IXC monolith. Existing data is sufficient for most information required to characterize the IXC monolith. New data collection necessary to support decision-making consists of the following.

- Determine the mass and volume of the IXC monolith.
- Manage free liquid by grouting to incorporate non-hazardous, free liquid inside the monolith.
- Design the monolith to minimize void space.

2.3.2 Determine the Source for This Information

This activity involves identifying the sources of information including the results of previous data collections, historical records, regulatory guidance, professional judgment, scientific literature, or collection of new data.

Table 2-9 shows the source of information to be used for the IXC monolith.

Appendix B provides the contaminant concentrations in the IXC monolith based on available information.

Table 2-9. Required Data Methods and Available Sources References for Ion Exchange Column Monolith. (2 sheets)

DS No.	Required Data	Survey/Sampling/ Data Collection Methods	Does Data Exist	Available Source References	Is the Data of Sufficient Quality (Y/N)	Additional Information Required (Y/N)
1	Data to determine if the waste is a TRU waste .	Process Knowledge	Y	HNF-6273 KBC-28343	Y	Y Volume and mass of monolith, monolith material inventory, and information of grouting process
2	Data to determine if the waste is regulated as a a dangerous waste in accordance with WAC 173-303.	Process knowledge	Y	EPA 14451 HNF-6273 HNF-6495 KBC-28343 WHC-EP-0877	Y	Y Monolith material inventory
3	Data to determine if the waste is LDR in accordance with WAC 173-303-140.	Process knowledge	Y	EPA 14451 HNF-6273 HNF-6495 KBC-28343	Y	Y Monolith material inventory and information of grouting process

Table 2-9. Required Data Methods and Available Sources References for Ion Exchange Column Monolith. (2 sheets)

DS No.	Required Data	Survey/Sampling/ Data Collection Methods	Does Data Exist	Available Source References	Is the Data of Sufficient Quality (Y/N)	Additional Information Required (Y/N)
4	Data to determine if the waste is a PCB waste regulated in accordance with 40 CFR 761.	Process knowledge	Y	HNF-6273 HNF-6495 KBC-28343	Y	Y Monolith material inventory
5	Data to determine if the waste complies with the ERDF waste acceptance criteria in BHI-00139	Process knowledge, radiological surveys and/or sampling and analysis	Y	HNF-6273 HNF-6495 HNF-SD-SNF-TI-009, Vol. 1 KBC-28343 UNI-1697	Y	Y Volume and mass of monolith, monolith material inventory, information of grouting process, dose rate and contamination surveys

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

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

EPA 14451, 2000, *Regulation of Concrete Residuals as Hazardous Waste*, RCRA online document No. 14451, U.S. Environmental Protection Agency, Washington, D.C.

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HNF-6495, 2001, *Sampling and Analysis Plan for K Basins Debris*, Rev. 1, Fluor Hanford, Inc., Richland, Washington.

HNF-SD-SNF-TI-009, 1999, 105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities, *Volume 1, Fuel*, Vol. 1, Rev. 3, FluorKBC-28343, 2006, *Disposal of K Basin Ion Exchange Column Evaluation*, Rev.1, Fluor Hanford, Inc., Richland, Washington

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

WHC-EP-0877, 1995, *K Basin Corrosion Program Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
PCB = polychlorinated biphenyl.
TSCA = *Toxic Substances Control Act of 1976*.
WAC = *Washington Administrative Code*.

2.3.3 Determine the Basis for Determining the Action Level

Action levels are the threshold concentrations of contaminants that are based on regulatory requirements, risk assessments, performance criteria for analytical methodology, or a reference standard.

Action levels for the IXC monolith are based on the BHI-00139 criteria, which were established in accordance with applicable regulatory requirements. Table 2-10 shows the action level and basis of the action level applicable to each COC.

Table 2-10. Action Levels for Ion Exchange Column Monolith Contaminants of Concern. (2 sheets)

Contaminants of Concern	Action Level	Basis
Radionuclides	> 1 pCi/g	BHI-00139 reportable limit
	(Ci/m^3)	BHI-00139 Table 2 conc. Limit unless noted
^{3}H	Unlimited	
^{14}C	5.1	0.4 Ci (BHI-00139, Table 3)
^{59}Ni	210	
^{60}Co	Unlimited	
^{63}Ni	700	
^{79}Se	28	
^{90}Sr	7,000	
^{93}Zr	140	
^{99}Tc	1.3	0.6 Ci (BHI-00139, Table 3)
^{107}Pd	830	
^{126}Sn	0.0085	
^{129}I	0.080	
^{134}Cs	Unlimited	
^{135}Cs	8.8	
^{137}Cs	32	
^{151}Sm	53,000	
^{152}Eu	21,000,000	
^{154}Eu	Unlimited	
$^{233/234}$U	0.074	
^{235}U	0.0027	
^{238}U + daughters	0.012	
Total uranium	Not applicable	3.0 Ci (BHI-00139, Table 3)
^{237}Np	0.0015	
^{238}Pu	1.5	
^{239}Pu	0.029	
^{240}Pu	0.029	
^{241}Pu	6.2	
^{242}Pu	0.11	
^{241}Am	0.050	
^{243}Am	0.057	

Table 2-10. Action Levels for Ion Exchange Column Monolith Contaminants of Concern. (2 sheets)

Contaminants of Concern	Action Level	Basis
^{242}Cm	20,000	
^{244}Cm	40	
TRU isotopes	100 nCi/g	BHI-00139
NRC Class C limits	Sum of fractions of Table 1 of 10 CFR 61.55	10 CFR 61.55
Chemical constituents	TCLP extract source as noted (mg/L)	WAC 173-303-090(8)(c) Toxicity characteristic list
As (D004)	5.0	WAC 173-303-090(8)(c)
Ba (D005)	100.0	WAC 173-303-090(8)(c)
Cd (D006)	1.0	WAC 173-303-090(8)(c)
Cr (total) (D007)	5.0	WAC 173-303-090(8)(c)
Cr (VI)	5.0	WAC 173-303-090(8)(c)
Pb (D008)	5.0	WAC 173-303-090(8)(c)
Hg (D009)	0.2	WAC 173-303-090(8)(c)
Se (D010)	1.0	WAC 173-303-090(8)(c)
Ag (D011)	5.0	WAC 173-303-090(8)(c)
PCB	PCB 10 mg/kg Non-liquid (>50 ppm regulated) Bulk liquid limited to ≤500 ppm	40 CFR 761
Free Liquid	Free liquid per SW-846 (9095)	WAC 173-303-140(4)(b) disposal of liquids;

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

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

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

SW-846, 1997, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, 3rd Edition, as amended, U.S. Environmental Protection Agency, Washington, D.C.

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

ERDF = Environmental Restoration Disposal Facility.
NRC = U.S. Nuclear Regulatory Commission.
PCB = polychlorinated biphenyl.
TCLP = toxicity characteristic leaching procedure.
TRU = transuranic.

2.3.4 Identify Sampling and Analysis Methods That Can Meet the Data Requirements

Sampling and analytical methods should be identified with sufficient detail to facilitate data collection appropriate for the problem being investigated. Appropriate specifications may include such information as sample size and instrument-specific detection limits. Sampling and analysis methods should strive to minimize decision errors (evaluated in Step 6 of the DQO process) by avoiding bias introduced through the following.

- Non-representative sampling
- Instability of samples between sampling and analysis
- Interferences and matrix effects in analysis
- Inability to determine the relevant forms of the parameters being measured
- Calibration
- Failure to blank-correct

Sampling and analysis are not necessary to characterize the IXC monolith. Information collection is limited to obtaining existing reports of basin water tests and the quantity of basin water that flowed through the IXCs. Information to be collected includes the formulation, volume, and density of grout added to the IXC monolith.

Collection of resin samples from the IXCs for chemical or radionuclide analysis is not necessary to support decision-making.

The following information is required to support disposal of the IXC monolith.

- Volume and density of grout added to the IXC monolith
- Measurement of the surface contamination and dose rate after grouting.

The following activities must be completed to support IXC monolith disposal.

- Grouting to minimize void space
- Grouting in compliance with macroencapsulation LDR.

2.4 STEP 4—DEFINE THE BOUNDARIES OF THE STUDY

Step 4 involves identifying the target population from which samples will be drawn and specifying the spatial and temporal features of the population pertinent to decision-making.

2.4.1 Define the Target Population of Interest

The target population for this DQO is the KE Basin IXC monolith including ancillary piping and instruments and the surrounding vault, which have been grouted in preparation for disposal at the ERDF. Characterization must be sufficient to resolve the DS identified in Table 2-8.

2.4.2 Specify the Spatial Boundaries That Clarify What the Data Must Represent

Drawing H-1-34834, *Parallel Ion Exchange System Piping Plan and Section,* shows the IXC cells and contents. The IXC monolith will include the cells, lead cave, IXCs with resin, internal piping, and external piping within the limits of the surrounding vault; and grout in the cells, the cave, and in the space between the columns and the vault. Drawing H-1-34837, *Structural Plans and Sections,* shows the ion column cells; the boundaries of the monolith are the exterior surfaces of the vault and the underlying 15-cm (6-in.) slab. The lead caves are located on the south side of the cells as shown in KBC-28343. See Figures 2-3 and 2-4 for location of the IXC cells and lead caves.

Figure 2-3. Ion Exchange Column Cells and Lead Caves (South Side).

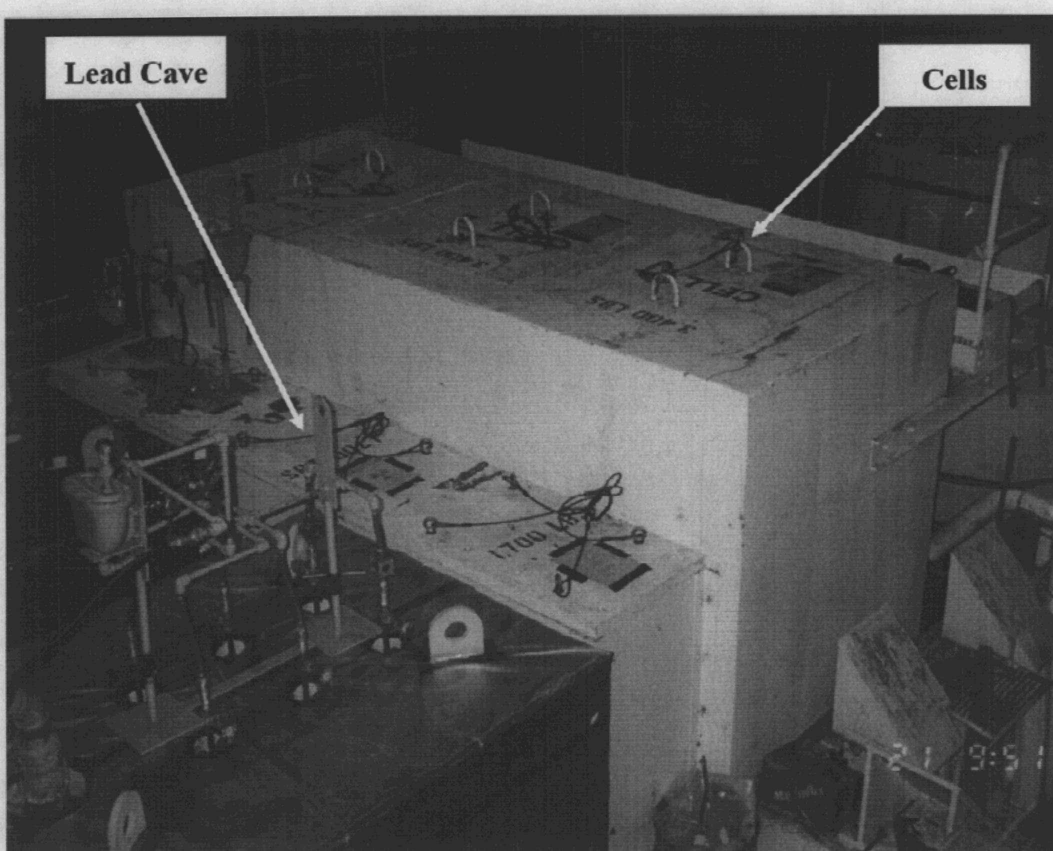
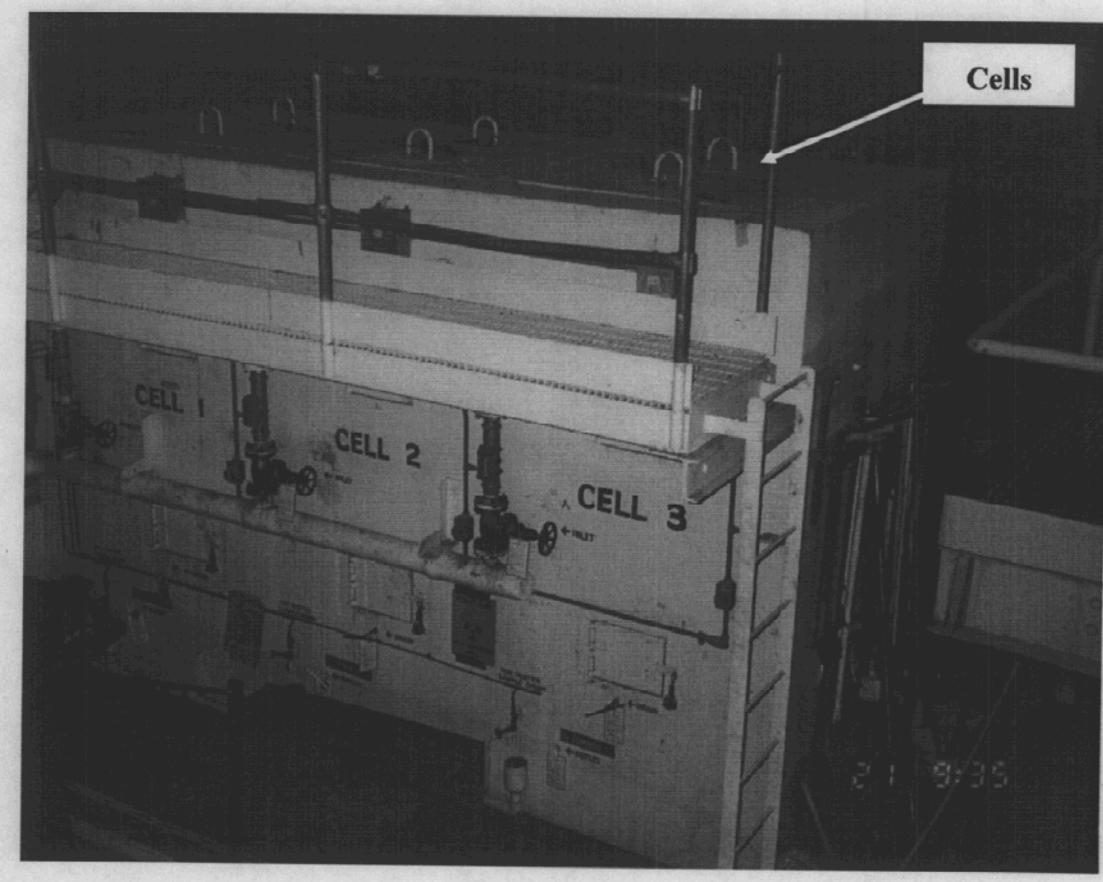


Figure 2-4. Ion Exchange Column Cells (North Side).



2.4.3 Determine the Timeframe of Collecting Data and Making the Decision

It is anticipated that the IXC cells and lead caves will be grouted in 2007 and the monolith removed as operational readiness allows. The volume and mass of the IXC monolith and the concentration of contaminants will be calculated. Calculation results will be used to determine the waste acceptance to the ERDF before adding grout to the cells and caves.

2.4.4 Determine the Practical Constraints on Collection Data

The open cells and lead caves are expected to exhibit substantial radiation dose rates, so personnel exposure will limit the work activities. Work shall be performed in a manner consistent with ALARA principles.

2.4.5 Determine the Smallest Subpopulation, Area, Volume, or Time of Which Separate Decisions Must be Made

Determining the smallest sample size establishes a means to control decision-making errors. U.S. Department of Transportation determinations will be made on the entire monolith. The mass and volume for radioactive waste classification purposes will be the cells and caves with grout. Dangerous waste determinations will be made on the contaminated lead cave and IXC resin media.

2.5 STEP 5—DEVELOP A DECISION RULE

2.5.1 Specify Appropriate Population Parameters

The quantity of resin in all six columns is known, as is the amount of water that ran through each column. The main isotopes are known in quantity to scale against the isotopes that were not measured. Multiple measurements are not necessary or advisable because of ALARA concerns. Appendix B reports mean analytical data. Mean measurements are used unless the waste cannot be characterized by assay or nondestructive assay. In such a case, calculations will use conservative (worst case) assumptions wherever uncertainty exists. Statistical methods are not required as the determination is a simple difference and a measurement of the entire population of one IXC monolith.

2.5.2 Confirm the Action Level Exceeds the Measurement Detection Limits

No direct comparison to action limits is required because the only measurements are the quantity resin media contaminating the ion columns, cells, caves, and the mass and volume of the monolith.

2.5.3 Develop a Decision Rule

Table 2-11 shows the DRs applicable to the IXC monolith.

2.6 STEP 6—SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Step 6 is used to establish the parameters for a statistically based sample design. A statistically based approach will not be used for the IXC monolith. One monolith will be produced as only six IXCs in cells and lead caves exist.

Table 2-11. Decision Rules for the Ion Exchange Column Filter Monolith.

DS No.	DR No.	Decision Rule
1	1	1. If the waste **is** a TRU waste, then dispose at the Hanford Site TSD facility in accordance with the WIPP acceptance criteria. 2. If the waste **is not** a TRU waste, then dispose at the ERDF or another Hanford Site TSD facility.
2	2	1. If the waste **is** a dangerous waste, then manage as dangerous waste in accordance to WAC 173-303 and the facility waste acceptance criteria. 2. If the waste **is not** a dangerous waste, then dispose at the ERDF in accordance with BHI-00139 or at another Hanford Site TSD facility.
3	3	1. If the waste **is** LDR, then treat waste prior to disposal to the ERDF or other Hanford Site TSD facility in accordance to WAC-173-303-140. 2. If the waste **is not** LDR, then dispose at the ERDF in accordance with BHI-00139 or at another Hanford Site TSD facility.
4	4	1. If the waste **is** a PCB waste, then dispose at the ERDF in accordance with BHI-00139 or at another Hanford Site TSD facility in accordance with 40 CFR 761.61. 2. If the waste **is not** a PCB waste, then dispose at the ERDF in accordance with BHI-00139 or at another Hanford Site TSD facility.
5	5	1. If the waste **does** comply with BHI-00139 waste acceptance criteria, then dispose at the ERDF. 2. If the waste **does not** comply with BHI-00139 waste acceptance criteria, then **do not** dispose at the ERDF, but at another Hanford Site TSD facility.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.
40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended.
WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

DR = decision rule.
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
LDR = Land Disposal Restricted.
PCB = polychlorinated biphenyl.
TRU = transuranic.
TSD = treatment, storage, and disposal.
WIPP = Waste Isolation Pilot Plant.

2.6.1 Determine the Range of the Parameters of Interest

The parameters to be measured are the resin media contaminating the ion columns, cells, and lead cave, and the mass and volume of the monolith. Most of the IXC monolith mass and volume may be used, less half of the lead cave, lead cave grout, and monolith form to determine the radioactive waste class. Table 2-3 shows the estimated total IXC monolith gross volume and weight. Table 2-4 shows the IXC monolith volume and weight deductions for waste classification.

It has been determined through other studies that the IXC resin may accumulate TC Metal and PCB above the regulatory threshold.

2.6.2 Choose a Null Hypothesis

A statistical method is not being used; therefore, this is not applicable.

2.6.3 Examine Consequences of Making an Incorrect Decision

Consequences of incorrect decisions may range from no consequence to regulatory noncompliance and damage to the environment.

The parameters to be considered to support decision-making are primarily process knowledge then monolith preparation such as the packaging, grouting process, monolith weight and volume, dose rate, and contamination of the monolith. The measurements collected are not statistically based, so quantitative error tolerances are not set.

Based on the calculated source term in the IXC monolith (Appendix B), the IXC monolith would not exceed 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," 61.55, "Waste Classification," Table 1 and Table 2 Class C limits. Because the IXC monolith source term is fixed, there would not be a consequence of an incorrect decision. The impact for an incorrect decision is possible effects to human health and the environment.

The monolith will not contain listed dangerous wastes. Although the monolith will contain regulated quantities of lead and other toxic metals, the waste will be encapsulated. The monolith will not contain persistent waste constituents. The monolith may contain small quantities of PCBs; however, the ERDF is authorized to accept unlimited quantities of PCB waste in solid form. The consequences of incorrect decisions in regard to chemical contamination are anticipated to be minimal because the macroencapsulated IXC monolith will be treated to satisfy the requirement 40 CFR 268.40, "Applicability of Treatment Standards," for treating radioactive lead solids.

All columns were drained when they were removed from service. If a small amount of liquid remained entrained in the column, it would have been removed by the normal evaporative process during the more than twelve years that the IXCs have been stored at the basin. The resins are expected to be dewatered to the extent necessary to pass a paint filter test. If free water did exist in a monolith, it would be incorporated into the waste form as grout is hydrophilic.

The IXC monolith will exhibit void spaces that will meet the ERDF acceptance criteria through structural stabilization of the IXC monolith itself. However, because the waste will be fully encapsulated with grout, the waste form meets waste encapsulation requirements that would prevent possible future subsidence or migration of any contaminants including lead from the lead shielding.

2.7 SPECIFY A RANGE OF VALUES WHERE CONSEQUENCES ARE MINOR (GRAY REGION)

If the *Resource Conservation and Recovery Act of 1976* constituents were determined to be greater than regulatory thresholds, the waste would nevertheless result in compliant disposal because the macroencapsulated IXC monolith will be treated to satisfy 40 CFR 268.40 requirements for treatment of radioactive lead solids.

2.7.1 Assign Probability Values to Points Above and Below the Action Level That Reflect Tolerable Probability for Potential Errors

A statistical approach is not applicable.

2.8 STEP 7—OPTIMIZE THE DESIGN FOR OBTAINING DATA

Step 7 is used to determine the most resource-effective data collection design for a statistically based sample design. A statistically based approach is not being used for the IXC monolith.

The NRC Branch Technical Position papers allow averaging. The averaging is done per regulator-approved document KBC-28343.

Only a few parameters can be considered for optimization. Reduction of dose rate to the IXC monolith can be achieved through the grouting process. Another parameter for optimization is the density of the grout that can be used. Process knowledge cannot be optimized, because that is what it is. The only sampling that will be taken are radiological smears.

3.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations,* as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations,* as amended.

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

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria,* Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

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DOE/EIS-0245, *Environmental Impact Statement-Management of Spent Nuclear Fuel from the K Basins at the Hanford Site,* U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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H-1-45071, 2000, *K-East Ion Exchange Module General Arrangement & PID,* Westinghouse Hanford Company, Richland, Washington.

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HNF-6495, 2001, *Sampling and Analysis Plan for K Basins Debris,* Rev. 1, Fluor Hanford, Inc., Richland, Washington.

HNF-27474, (Draft), *One-Time Request for Shipment 105-KE Monoliths,* Rev.0, Fluor Hanford, Inc., Richland, Washington.

HNF-SD-SNF-TI-009, 1999, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities, Volume I, Fuel,* Vol. 1, Rev. 3, Fluor Hanford, Inc., Richland, Washington.

HNF-SD-SNF-TI-015, 2001, *Spent Nuclear Fuel Project Technical Databook,* Rev. 7, Fluor Hanford, Inc., Richland, Washington.

KBC-28343, 2006, *Disposal of K Basin Ion Exchange Column Evaluation,* Rev. 1, Fluor Hanford, Inc., Richland, Washington.

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UNI-1697, 1981, *KE Fuel Storage Basin Activity Mapping in Support of Exposure Reduction,* United Nuclear Industries, Inc., Richland, Washington.

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WHC-EP-0877, 1995, *K Basin Corrosion Program Report,* Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

ESTIMATED ION EXCHANGE COLUMN MONOLITH MASS AND VOLUME

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APPENDIX A

ESTIMATED ION EXCHANGE COLUMN MONOLITH MASS AND VOLUME

The lead caves and concrete cells currently containing the Ion Exchange Columns (IXC) will be solidified/stabilized in the grouted waste form before disposal at the Environmental Restoration Disposal Facility (ERDF). The waste materials contained in the grouted IXC monolith will have the following characteristics.

- Each IXC is an 18-in. diameter schedule 10 pipe with ¼-in. walls and a 17.5–in. inner diameter.
- The IXCs have a maximum gross weight of 800 lb and have an 8 ft^3 capacity. The resin occupies the center 5 ft^3 of the column.
- Table A-1 presents estimates of the constituents, volumes, and weights associated with the monolith waste form based on 150 lb/ft^3 density structural concrete and 105 lb/ft^3 density grout being added. The monolith is estimated to measure approximately 10 ft 6 in. wide, 17 ft long, and 12 ft high and weigh 279,291 lb.

The total *ungrouted* void space of the monolith containing the six IXCs is conservatively estimated to total 18 ft^3 (i.e., approximately 1,050 gal).

Table A-1 calculates the total weight and volume of the monolith containing the IXCs. Table A-2 calculates the weight and volume of the monolith containing the IXCs that is not appropriate to consider for determining the concentration of radionuclides in accordance with the U.S. Nuclear Regulatory Commission (NRC) radioactive waste classification requirements. These weight and volume deductions consist of the external concrete layer placed around the cave and cells for structural purposes and half of the lead caves as the lead cave is only half full of IXCs. The waste volume and mass that is appropriate to average the concentration of radionuclides contained in the monolith for determination of radioactive waste class is the total values shown in Table A-1 less the total values shown in Table A-2, which is 1,841 ft^3 and 254,393 lb.

Table A-1. Estimated Total Monolith Gross Volume and Weight Information.[1] (2 sheets)

Component	Volume (ft^3)	Weight (lb)
IXCs and Associated Components	4.8	2,116
6-IXCs[2]	4	1,920
Associated Piping	0.8	196
Concrete Cells 6 ft W x 15 ft L x 10 ft 1 in. H[2]	964.6	145,000
Lead Caves 165 in. L x 30 in. W x 72 in. H	27.8	18,360
Steel Skin	5.5	1,339
Lead shielding	21.9	7,740

Table A-1. Estimated Total Monolith Gross Volume and Weight Information.[1] (2 sheets)

Component	Volume (ft^3)	Weight (lb)
Steel Frame	0.4	98
Concrete Floor 10 ft 6 in. W x 17 ft L x 1 ft D	178	26,775
Monolith Form (1 ft larger in every dimension)	488	4,904
Steel Skin (⅛-in. steel plate)	7	3,370
Structural Ribs	481	1,534
Grout	782.3	82,136
Total monolith	2,446	279,291

[1]The volumes and weights associated with this table were calculated using drawings H-1-34789, H-1-34834, H-1- 34837, H-1-45071, and H-1-21072. A specific calculation was performed by engineering on 4/28/05. Some numbers were rounded when placed in this table.

[2]The volume of IXCs shown here is not the total vessel volume of 8 ft^3 but the volume of resin inside the vessels of 4 ft^3. It is expected that grout will fill the empty 4 ft^3 inside of the IXCs.

IXC = Ion Exchange Column.

Table A-2. Monolith Volume and Weight Deductions for Waste Classification.

Component	Volume (ft^3)	Weight (lb)
Half of Lead Caves 165 in. L x 30 in. W x 72 in. H[3]	13.9	9,180
Monolith Form (1 ft larger in every dimension)	488	4,904
Half of Lead Cave Grout	103.2	10,814
Total weight being subtracted from total monolith weight for waste classification.	605	24,898

[3]The use of half the lead cave weight and half the grout weight in the caves was due to only 3 IXC's are stored in the caves, when the caves could hold up to 6 IXCs in storage.

IXC = Ion Exchange Column.

APPENDIX B

RADIONUCLIDE/ISOTOPE CONTAMINANTS OF POTENTIAL CONCERN AND RATIONAL FOR SELECTION

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APPENDIX B

RADIONUCLIDE/ISOTOPE CONTAMINANTS OF POTENTIAL CONCERN AND RATIONAL FOR SELECTION

The Ion Exchange Columns (IXC) were last run from 1992 to 1993. During the operation of these six IXCs, the underwater work activity in the 105-KE (KE) Basin was minimal. There was occasional debris removal and some movement of sludge to get to some debris, but for the most part, underwater activities were minimal. Based on the low underwater activity, the source term used for this characterization was derived from the N Reactor fuel source term in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook,* Table 4-12b. BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Section 3.2.1.1, requires that major radionuclides be known and recorded during the waste management process. One of these requirements is to report major radionuclides with a half-life greater than 2 years. Each radionuclide that was reported from the N Reactor Fuel source term was compared to the half-life greater than 2 years criteria and identified as having a half-life less than 2 years in table B-1. Each isotope identified as having a half-life less than 2 years will be eliminated from reporting. One isotope is a gas, Kr-85, and would not be present in the IXC resin, so this isotope will be eliminated.

The fuel source term in Table B-1, was decay-corrected from 5/31/1998 to 9/26/2006 to represent the source term better. Isotope ratios were established after decay correcting. Isotope inventory was calculated based on IXC inlet water samples analysis and runtimes for Sr-90, Cs-137, Pu-238, and Pu-239. All other isotopes were ratioed to Cs-137 and Pu-239. Any isotope with an atomic weight less than 210 were ratioed to Cs-137, and any isotope with an atomic weight equal to or greater than 210 were ratioed to Pu-139. Established decay-corrected ratios were used when developing ratios. The BHI-00139 reporting criteria were evaluated for each isotope and any isotope that did not meet the reporting criteria was eliminated from reporting.

Table B-1. Radionuclide Selection based on N-Reactor Fuel Decay Corrected. (3 sheets)

Isotope Name	Isotope Symbol	Half Life Years	N-Reactor Fuel Activity 1998 Ci	N-Reactor Fuel Activity 2006 Ci	1998 N-Fuel Activity % of Cs-137	2006 N-Fuel Activity % of Cs-137	Half Life (Less than) < 2 Years
Tritium	H-3	1.23E+01	1.80E+04	1.13E+04	0.27%	0.21%	
Carbon	C-14	5.73E+03	3.62E+02	3.62E+02	0.0055%	0.0067%	
Chromium	Cr-51	7.59E-02	1				YES
Manganese	Mn-54	8.56E-01	1				YES
Iron	Fe-55	2.70E+00	9.64E+02	1.17E+02	0.015%	0.0022%	
Nickel	Ni-59	8.00E+04	2.11E+01	2.11E+01	0.00032%	0.00039%	
Cobalt	Co-60	5.27E+00	1.86E+03	6.23E+02	0.028%	0.012%	
Nickel	Ni-63	1.00E+02	2.30E+03	2.17E+03	0.035%	0.040%	

Table B-1. Radionuclide Selection based on N-Reactor Fuel Decay Corrected. (3 sheets)

Isotope Name	Isotope Symbol	Half Life Years	N-Reactor Fuel Activity 1998 Ci	N-Reactor Fuel Activity 2006 Ci	1998 N-Fuel Activity % of Cs-137	2006 N-Fuel Activity % of Cs-137	Half Life (Less than) < 2 Years
Selenium	Se-79	6.50E+04	4.35E+01	4.35E+01	0.00066%	0.0008%	
Krypton	Kr-85	1.06E+01	2				
Strontium	Sr-89	1.38E-01	1				YES
Strontium	Sr-90	2.90E+01	4.96E+06	4.06E+06	76%	75%	
Zirconium	Zr-93	1.50E+06	2.01E+02	2.01E+02	0.0031%	0.0037%	
Niobium	Nb-93m	3.50E+03	1.26E-02	5.90E+01	0.00000019%	0.0011%	
Niobium	Nb-95	9.51E-02					YES
Niobium	Nb-95m	9.88E-03					YES
Zirconium	Zr-95	1.75E-01	1				YES
Technetium	Tc-99	2.13E+05	1.45E+03	1.45E+03	0.022%	0.027%	
Ruthenium	Ru-106	1.01E-01	1				YES
Ruthenium	Rh-106	5.69E-05	1				YES
Palladium	Pd-107	6.50E+06	8.59E+00	8.59E+00	0.00013%	0.00016%	
Silver	Ag-110	4.67E-05	1				YES
Silver	Ag-110m	6.84E-02	1				YES
Cadmium	Cd-113m	1.37E+01	1.80E+03	1.18E+03	0.027%	0.022%	
Indium	In-113m	1.89E-03	1				YES
Tin	Sn-113	3.15E-01	1				YES
Tin	Sn-119m	8.02E-02	1				YES
Tin	Sn-121m	2.97E-03	1				YES
Tin	Sn-123	3.53E-02	1				YES
Tellurium	Te-123m	3.27E-01	1				YES
Antimony	Sb-124	1.64E-01	1				YES
Antimony	Sb-125	2.73E+00	1.69E+04	2.09E+03	0.26%	0.039%	
Antimony	Sb-126	3.40E-02	1				YES
Tellurium	Te-125m	1.59E-01	1				YES
Tin	Sn-126	1.00E+05	8.07E+01	8.07E+01	0.0012%	0.0015%	
Antimony	Sb-126	3.40E-02	1				YES
Antimony	Sb-126m	3.61E-05	1				YES
Tellurium	Te-127	1.06E-03	1				YES
Tellurium	Te-127m	2.98E-01	1				YES
Tellurium	Te-129	7.94E-03	1				YES
Tellurium	Te-129m	9.21E-02	1				YES

Table B-1. Radionuclide Selection based on N-Reactor Fuel Decay Corrected. (3 sheets)

Isotope Name	Isotope Symbol	Half Life Years	N-Reactor Fuel Activity 1998 Ci	N-Reactor Fuel Activity 2006 Ci	1998 N-Fuel Activity % of Cs-137	2006 N-Fuel Activity % of Cs-137	Half Life (Less than) < 2 Years
Iodine	I-129	1.57E+07	3.26E+00	3.26E+00	0.00005%	0.00006%	
Cesium	Cs-134	2.06E+00	6.95E+03	4.25E+02	0.11%	0.0079%	
Cesium	Cs-135	2.30E+06	3.96E+01	3.96E+01	0.00060%	0.00073%	
Cesium	Cs-137	3.02E+01	6.55E+06	5.41E+06	100%	100%	
Cerium	Ce-144	7.82E-01	1				YES
Praseodymium	Pr-144	1.97E-03	1				YES
Praseodymium	Pr-144m	8.22E-04	1				YES
Promethium	Pm-147	2.62E+00	2.45E+05	2.72E+04	3.7%	0.50%	
Samarium	Sm-151	9.30E+01	8.92E+04	8.37E+04	1.4%	1.5%	
Europium	Eu-152	1.34E+01	4.67E+02	3.05E+02	0.0071%	0.0056%	
Europium	Eu-154	8.20E+00	5.30E+04	2.71E+04	0.81%	0.50%	
Europium	Eu-155	4.76E+00	1.12E+04	3.41E+03	0.17%	0.063%	
Gadolinium	Gd-153	6.62E-01	1				YES
Terbium	Tb-160	1.98E-01	1				YES
Uranium	U-234	2.44E+05	4.66E+02	4.67E+02	0.0071%	0.0086%	
Uranium	U-235	7.04E+08	1.77E+01	1.77E+01	0.00027%	0.00033%	
Uranium	U-236	3.42E+06	6.61E+01	6.61E+01	0.0010%	0.0012%	
Uranium	U-238	4.47E+09	3.80E+02	3.80E+02	0.0058%	0.007%	
Neptunium	Np-237	2.14E+06	3.02E+01	3.08E+01	0.00046%	0.00057%	
Plutonium	Pu-238	8.77E+01	6.05E+04	5.67E+04	0.92%	1.0%	
Plutonium	Pu-239	2.41E+04	1.16E+05	1.16E+05	1.8%	2.1%	
Plutonium	Pu-240	6.54E+03	6.37E+04	6.36E+04	0.97%	1.2%	
Plutonium	Pu-241	1.47E+01	3.42E+06	2.29E+06	52%	42%	
Plutonium	Pu-242	3.76E+05	3.07E+01	3.07E+01	0.00047%	0.00057%	
Americium	Am-241	4.32E+02	2.06E+05	2.41E+05	3.1%	4.4%	
Americium	Am-242	4.39E-02	1				YES
Americium	Am-242m	1.52E+02	1.14E+02	1.09E+02	0.0017%	0.002%	
Americium	Am-243	7.38E+03	7.12E+01	7.11E+01	0.0011%	0.0013%	
Curium	Cm-242	4.47E-01	1				YES
Curium	Cm-244	1.81E+01	8.71E+02	6.33E+02	0.013%	0.012%	

[1]Isotope eliminated due to the half life being less than 2 years.
[2]Kr-85 eliminated because element exists as a gas, in which will not be retained in the water.

The radiological characterization of the monolith is based on the IXCs as it dominates the inventory. The radionuclide inventories for the IXCs are calculated for Cs-137, Sr-90 Pu-238, and Pu-239 by subtracting the outlet concentration from the inlet concentration to determine the concentration captured on the IXC, and then multiply times the flow rate, and time in service. Before calculating the radionuclide inventory for Cs-137, Sr-90, Pu-238 and Pu-239, a decay correction was performed from the original inventory date to 9/23/2006.

Table B-2. Determination of Final Radionuclide COCs Selection. (2 sheets)

Nuclide	N-Fuel Nuclide Distribution (unitless)	Analysis Radionuclide Inventory (Ci)	Total Radionuclide Inventory (Ci)		Total Radionuclide Inventory (pCi/g)	Decision
H-3	2.08E-03		2.04E-01	1	1.77E+03	Retain- >1 pCi/g
C-14	6.68E-05		6.54E-03	1	5.66E+01	Retain- >1 pCi/g
Fe-55	2.16E-05		2.12E-03	1	1.83E+01	Retain- >1 pCi/g
Ni-59	3.90E-06		3.82E-04	1	3.31E+00	Retain- >1 pCi/g
Co-60	1.15E-04		1.13E-02	1	9.75E+01	Retain- >1 pCi/g
Ni-63	4.01E-04		3.93E-02	1	3.40E+02	Retain- >1 pCi/g
Se-79	8.04E-06		7.87E-04	1	6.81E+00	Retain- >1 pCi/g
Sr-90	7.50E-01	4.21E+01	4.21E+01		3.64E+05	Retain- >1 pCi/g
Zr-93	3.72E-05		3.64E-03	1	3.15E+01	Retain- >1 pCi/g
Nb-93m	1.09E-05		1.07E-03	1	9.23E+00	Retain- >1 pCi/g
Tc-99	2.68E-04		2.62E-02	1	2.27E+02	Retain- >1 pCi/g
Pd-107	1.59E-06		1.55E-04	1	1.35E+00	Retain- >1 pCi/g
Cd-113m	2.18E-04		2.14E-02	1	1.85E+02	Retain- >1 pCi/g
Sb-125	3.86E-04		3.78E-02	1	3.27E+02	Retain- >1 pCi/g
Sn-126	1.49E-05		1.46E-03	1	1.26E+01	Retain- >1 pCi/g
I-129	6.03E-07		5.90E-05	1	5.11E-01	Remove - not >1 pCi/g
Cs-134	7.86E-05		7.69E-03	1	6.66E+01	Retain- >1 pCi/g
Cs-135	7.32E-06		7.16E-04	1	6.20E+00	Retain- >1 pCi/g
Cs-137	1.00E+00	9.79E+01	9.79E+01		8.47E+05	Retain- >1 pCi/g
Pm-147	5.02E-03		4.91E-01	1	4.25E+03	Retain- >1 pCi/g
Sm-151	1.55E-02		1.51E+00	1	1.31E+04	Retain- >1 pCi/g
Eu-152	5.63E-05		5.51E-03	1	4.77E+01	Retain- >1 pCi/g
Eu-154	5.01E-03		4.90E-01	1	4.24E+03	Retain- >1 pCi/g
Eu-155	6.30E-04		6.16E-02	1	5.34E+02	Retain- >1 pCi/g
U-234	8.64E-05		9.13E-03	2	7.91E+01	Retain- >1 pCi/g
U-235	3.27E-06		3.46E-04	2	3.00E+00	Retain- >1 pCi/g
U-236	1.22E-05		1.29E-03	2	1.12E+01	Retain- >1 pCi/g
U-238	7.02E-05		7.43E-03	2	6.43E+01	Retain- >1 pCi/g
Np-237	5.70E-06		6.02E-04	2	5.21E+00	Retain- >1 pCi/g

Table B-2. Determination of Final Radionuclide COCs Selection. (2 sheets)

Nuclide	N-Fuel Nuclide Distribution (unitless)	Analysis Radionuclide Inventory (Ci)	Total Radionuclide Inventory (Ci)		Total Radionuclide Inventory (pCi/g)	Decision
Pu-238	1.05E-02	2.85E-01	2.85E-01		2.47E+03	Retain- >1 pCi/g
Pu-239	2.14E-02	2.27E+00	2.27E+00		1.96E+04	Retain- >1 pCi/g
Pu-240	1.18E-02		1.24E+00	2	1.08E+04	Retain- >1 pCi/g
Pu-241	4.23E-01		4.48E+01	2	3.88E+05	Retain- >1 pCi/g
Pu-242	5.67E-06		6.00E-04	2	5.20E+00	Retain- >1 pCi/g
Am-241	4.45E-02		4.70E+00	2	4.07E+04	Retain- >1 pCi/g
Am-242m	2.02E-05		2.14E-03	2	1.85E+01	Retain- >1 pCi/g
Am-243	1.31E-05		1.39E-03	2	1.20E+01	Retain- >1 pCi/g
Cm-244	1.17E-04		1.24E-02	2	1.07E+02	Retain- >1 pCi/g

1. Isotopes atomic weights less than 210 are ratioed to Cs-137.
2. All other isotopes with atomic weight of 210 and higher are ratioed to Pu-239.
3. The mass of the treated matrix is 126,684 kg (279,291 lb) gross weight less 11,294 kg (24,898 lb) half lead cave half lead cave grout; net waste mass is 115,391 (254,393 lb).

The activities of other isotopes were ratioed from Cs-137 and Pu-239. All isotopes with an atomic weight less than 210 were ratioed to Cs-137, otherwise any isotope with an atomic weight greater than 210 were ratioed to Pu-239. The other criteria for elimination from BHI-00139, section 3.2.1.1, requires major radionuclides be reported in a concentration in excess of 1 pCi/g. I-129 will be eliminated from this reporting criteria as the amount was calculated as less than 1 pCi/g.

REFERENCES

HNF-SD-SNF-TI-015, 2001, *Spent Nuclear Fuel Project Technical Databook,* Rev. 7, Fluor Hanford, Inc., Richland, Washington.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

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