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Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2024

JANUARY 2025

A. Jeffrey Sondrup
Kira Overin
Jonathan Jacobson
James Angell
Tim Arsenault

Idaho National Laboratory

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Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

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Tim Arsenault
Idaho National Laboratory

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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EXECUTIVE SUMMARY

This Fiscal Year (FY) 2024 annual summary report (ASR) documents the continued adequacy of the performance assessment (PA), the composite analysis (CA),[1] and associated operating disposal-authorization statement (ODAS) technical-basis documents for the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility at Idaho National Laboratory (INL). Annual review of the adequacy of the PA and CA for RHLLW Disposal Facility ensures that conclusions of the analyses remain valid in accordance with requirements of the U.S. Department of Energy (DOE) Order 435.1, "Radioactive Waste Management."

In FY 2024, no significant operational changes or other activities occurred that would cause deviation from the assumptions in the PA and CA pertaining to disposal geometry, verification of waste characteristics, tracking disposal inventories against total limits, facility closure design, or institutional controls. Nineteen waste canister shipments were received at the RHLLW Disposal Facility, and all nineteen waste canisters were emplaced in disposal vaults.

In FY 2024, the facility monitoring plan (PLN-5501) and the change-control document (RH-ADM-5214) were updated. There were no revisions to the PA, CA, ODAS, radioactive waste management basis (RWMB), or other technical-basis documents in FY 2024. The PLN-5501 and RH-ADM-5214 updates are discussed in Section 2.9.2. Current versions of the technical-basis documents are as follows:

- Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility, DOE/ID-11421, Revision 2
- Composite Analysis for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility, DOE/ID-11422, Revision 0
- Addendum to the Composite Analysis for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility, DOE/ID-11577, Revision 0
- PLN-3368, "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," Revision 3
- PLN-5501, "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 3
- PLN-3370, "Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0
- PLN-5503, "Addendum to the Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0
- PLN-5446, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2
- "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," RH-ADM-5214, Revision 1.

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1 The facility CA comprises the original CA (DOE/ID-11422, Revision 0) and the subsequently issued addendum (DOE/ID-11577, Revision 0). All references to the CA herein are intended to reflect the technical content of both documents.

Ongoing Activities

In FY 2024, most routine PA and CA maintenance activities remained unchanged in accordance with the PA/CA maintenance plan (PLN-3368), "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis." Changes to facility monitoring commenced in FY 2024 as the post-baseline monitoring phase began. This involved reducing the number of lysimeters sampled and reducing lysimeter-sample analytes to gross alpha, gross beta, and tritium. These changes were mostly anticipated and are described in the facility monitoring plan (PLN-5501). No new activities or information were identified in FY 2024 that might change assumptions and conclusions of the PA, CA, ODAS, or RWMB. Further, no activities or information were identified that would impact assumptions and conclusions of the PA and CA, including land-use plans, waste acceptance criteria (WAC), future disposals, disposed-of inventory changes, or interim and final closure plans.

New proposed activities, changes in existing activities, facility configuration changes, and new information that could potentially impact the conclusions or assumptions of the PA, CA, ODAS, or RWMB were identified and evaluated through the unreviewed disposal question screening (UDQS)/unreviewed disposal question evaluation (UDQE) process, as detailed in RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility."

The process identified seven UDQS/UDQEs that were in progress at the end of FY 2023 and 27 UDQS/UDQEs that were initiated in FY 2024 for a total of 34. Of the 34 UDQS/UDQEs, two were screened negative and approved, three were in the process of being screened, and 29 were screened positive requiring an evaluation. Of the 29 required evaluations, 28 were completed and determined to be negative, meaning the change, activity, or new information was determined to be within the bounds of the PA, CA, and ODAS. One evaluation was still in progress at the end of FY 2024.

Waste Receipts

Waste canister shipments from the Advanced Test Reactor (ATR) Complex commenced in FY 2024. Waste streams approved for shipment to the RHLLW Disposal Facility in FY 2024 include (1) activated metals (AMs) and surface-contaminated debris in Hot Fuel Examination Facility (HFEF)-5 canisters from the Materials and Fuels Complex (MFC), (2) AMs in ATR-5 canisters from the ATR Complex, and (3) AMs and surface-contaminated debris in 55-ton canisters from Naval Reactors Facility (NRF). In FY 2024, one HFEF-5 waste canister and three ATR-5 canisters were shipped to the facility and emplaced in the HFEF-vault array (Array 2). This brings the total number of waste canister disposals in the HFEF-vault array to 69 at the end of FY 2024 and leaves space for 111 additional canisters of this type or size. Fifteen 55-ton canisters were shipped to the facility and emplaced in the 55-ton vault array (Array 3) in FY 2024, which brings the total number of 55-ton canister disposals to 20 and leaves space for 148 additional canisters of this type. No other vault arrays received waste, and the facility is at 9.48% of capacity based on the number of canisters.

A running total of radionuclide activities by vault array, generator, and waste form is recorded and tracked using the facility inventory management system, RHLLW Inventory Online (RHINO)[2] (TFR-981 2018). In FY 2024, 230 radionuclides were reported in AMs, and 103 radionuclides were reported as surface contamination for a total activity of 16,311 Ci in all 19 waste canisters emplaced during the fiscal year. Four of the reported radionuclides are non-system radionuclides, meaning they were not considered in the PA and are not included in the RHINO database. Non-system radionuclides are evaluated using the UDQE process (see Section 2.1).

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2 RHINO (Remote-Handled Low-Level Waste Disposal Facility Inventory Online) is an NQA-1 software application for accepting, managing, and tracking the receipt of waste and its disposal location. The technical and functional requirements for RHINO are found in TFR-981, "Remote-Handled-LLW Inventory Online Database."

In FY 2024, all 14 radionuclides fully analyzed in the PA for the groundwater (all-pathway) dose were reported in the waste canisters. All five radionuclides that contribute most to the PA intruder-pathway dose (Co-60, Cs-137, Nb-94, Ni-63, and Sr-90) were reported. All three radionuclides that most contribute to the PA air-pathway dose (C-14, tritium [H-3], and I-129) were reported. All nine radionuclides that contribute to the PA beta-gamma dose equivalent and the beta-gamma effective dose (C-14, Cl-36, H-3, I-129, Mo-93, Nb-94, Ni-59, and Tc-99) were also reported.

The cumulative inventory of radionuclides in NRF 55-ton canisters is approximately as expected or less than expected for most of the 14 groundwater pathway radionuclides and waste forms based on projections used in the PA. Inventories of three radionuclides (Np-237, Pu-240, and U-234) as surface contamination are significantly larger than PA projections. For HFEF-5 and ATR-5 canisters, inventories of five radionuclides (Np-237, Pu-240, U-234, U-235 and U-238) as surface contamination are significantly larger than PA projections. However, most of the inventory of these radionuclides were from HFEF-5 canister disposals prior to FY 2023. All occurrences of canisters with higher-than-expected inventories are flagged by RHINO and evaluated through the UDQE process. Although the inventories are greater than expected, they are typically small compared to the total PA inventories for all generators and canisters.

Facility performance is calculated and tracked for each canister using RHINO. The calculated maximum dose and concentration performance measures from the 19 waste canisters disposed of in FY 2024 are a very small fraction of the applicable performance objectives, and the impact of disposals is within the bounds of PA predictions. There are no impacts to the assumptions or conclusions of the PA.

Facility and Environmental Monitoring

Facility monitoring consists of annual compaction measurements and inspections of the vault-yard road apron, vault shield plug surfaces for damage, and the vault yard and side slopes for evidence of biotic activity (e.g., burrowing insects, animals, and plants). The FY 2024 inspection of the vault-yard road apron showed typical rutting, settling, erosion, sedimentation, and uneven surfaces consistent with past annual inspections. All findings were deemed not significant in nature and expected for gravel surfaces, especially in industrial areas where heavy equipment is being operated. The vault inspection revealed damage to four vault shield plugs. The damage is relatively minor, and repairs will be completed in FY 2025. Moderate vegetation (weed) growth was observed in a few areas of the vault-yard perimeter, and the vegetation was sprayed and/or removed. No evidence of burrowing insects or animals was identified. Compaction measurements were completed and show there are no significant issues and only typically expected changes from initial configuration/conditions.

Environmental monitoring was conducted in FY 2024 in accordance with PLN-5501. Compliance monitoring consists of collecting and analyzing water samples from three aquifer wells (one upgradient, two downgradient) near the facility. Samples are collected annually from each well and analyzed to confirm compliance with federal drinking water and state groundwater quality standards (IDAPA 58.01.11). Performance monitoring is conducted by collecting and analyzing soil-porewater samples from vadose-zone lysimeters installed in native materials adjacent to and below the base of the vault arrays.

Aquifer water samples were analyzed for indicator analytes gross alpha and gross beta, and for target analytes C-14, H-3, I-129, and Tc-99. Tritium was detected in all three aquifer wells at levels less than the drinking water maximum-contaminant level, and concentrations continue to exhibit a decreasing trend. Gross beta was positively detected in all three aquifer wells, while gross alpha was positively detected in two wells. C-14, I-129, and Tc-99 were not detected in any samples. All results are consistent with concentrations in the aquifer established prior to facility completion (INL 2017).

FY 2024 was the first year of the post-baseline monitoring phase which resulted in changes to performance monitoring. During this phase, lysimeter samples are collected annually from a subset of lysimeters selected based on coverage and demonstrated water production according to the monitoring plan. Samples are analyzed for target analytes gross alpha and gross beta, and indicator analyte tritium. Gross alpha and gross beta were positively identified in all six lysimeters in either the original sample or the duplicate. Tritium was positively identified in one lysimeter (HFEF-South), which is consistent with the previous year. All FY 2024 performance-monitoring sample results were less than action levels and within the bounds identified in the baseline data summary report (INL 2023b).

Design, Operations, and Closure Conditions

During FY 2024, there were no changes in the design, construction, or operation of the RHLLW Disposal Facility that were not considered in the PA or CA. While the commencement of shipment and disposal of ATR-5 waste canisters from ATR Complex in FY 2024 constituted a change in operations at the facility, this activity was anticipated and considered during preparation of the PA and CA. Therefore, it has no impact on the adequacy of the PA or CA.

The preliminary closure plan (PLN-3370) and the preliminary closure plan addendum (PLN-5503) outline the timeline and general procedure for the closure of the RHLLW Disposal Facility. When used together, these two plans form the closure basis for the facility.

Special Analyses

No UDQEs were evaluated as requiring a special analysis; therefore, no special analyses were required or prepared. The WAC allows for special-case disposals on a case-by-case basis after a documented request for deviation and subsequent approval of a special analysis. However, no special-case disposals were performed or are anticipated as of this ASR.

Research and Development Activities

No research and development activities were conducted at the RHLLW Disposal Facility in FY 2024.

Planned or Contemplated Changes

Planned or contemplated changes for FY 2024 include updating tables in Appendix B of the WAC to include radionuclides that could be reported in approved waste streams that were not included in the projected PA base case inventory. A potential change may occur subject to the results of an evaluation of projected inventory discrepancies in HFEF-5 canisters. No changes are planned or contemplated for facility design, construction, or closure. No identified changes are expected to impact the conclusions of the PA or CA.

Status of ODAS Conditions, Key, and Secondary Issues

No conditions or limitations placed on disposal operations at the RHLLW Disposal Facility were identified in the ODAS. No outstanding key or secondary issues are associated with the PA, CA, or ODAS technical-basis documents.

CONTENTS

FIGURES

TABLES

ACRONYMS

AM	activated metal
ASR	Annual Summary Report
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
CA	composite analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLUES	Comprehensive Land Use and Environmental Stewardship
CVAS	Cask-to-Vault Adapter System
DOE	Department of Energy
DOE-EM	Department of Energy Environmental Management
DOE-ID	Department of Energy Idaho Operations Office
ECAR	Engineering Calculations and Analysis Report
ECF	Expended Core Facility
FE	facility evaluation
FY	fiscal year
HFEF	Hot Fuel Examination Facility
INL	Idaho National Laboratory
LCC	large concept cask
LFRG	(DOE) Low-Level Waste Disposal Facility Federal Review Group
MCL	maximum-contaminant level
MFC	Materials and Fuels Complex
MWO	model work order
NRF	Naval Reactors Facility
ODAS	operating disposal authorization statement
PA	performance assessment
PM	preventative maintenance
RHINO	Remote-Handled Low-Level Waste Disposal Facility Inventory Online
RHLLW	Remote-Handled Low-Level Waste
RWMB	radioactive waste management basis
SC	surface contaminated
UDQE	unreviewed disposal question evaluation
UDQS	unreviewed disposal question screening

VSP	vault shield plug
WAC	waste acceptance criteria
WO	Work Order

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Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2024

1. INTRODUCTION

The U.S. Department of Energy (DOE) requires the performance assessment (PA) (Department of Energy Idaho Operations Office [DOE-ID] 2018a), composite analysis (CA) (DOE-ID 2012), and CA addendum (DOE-ID 2018b)[3] for the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility at the Idaho National Laboratory (INL) Site shall be maintained to evaluate changes that could affect the performance, design, and operating basis for the facility (DOE Manual 435.1-1 Change 3, "Radioactive Waste Management Manual," Section IV.P. [4]).

The RHLLW Disposal Facility became operational in September 2018 after the completion of operational readiness activities required by DOE Order 425.1D, "Verification of Readiness to Start Up or Restart Nuclear Facilities," and the issuance of the startup authorization by the Startup Approval Authority (Boston 2018). The first waste disposals at the RHLLW Disposal Facility began in Fiscal Year (FY) 2019.

In Fiscal Year (FY) 2024, no significant operational changes or other activities occurred that would cause deviation from the assumptions in the PA and CA pertaining to disposal geometry, verification of waste characteristics, tracking disposal inventories against total limits, facility closure design, or institutional controls.

This FY 2024 annual summary report (ASR) documents the continued adequacy of the PA, CA, operating disposal authorization statement (ODAS) (ODAS 2018), ODAS technical-basis documents, and the radioactive waste management basis (RWMB) (RWMB, INL 2020a) to meet DOE Order 435.1, "Radioactive Waste Management," performance objectives for the RHLLW Disposal Facility. Annual review of the adequacy of the PA and CA at the RHLLW Disposal Facility ensures that conclusions of the analyses remain valid in accordance with requirements of DOE Order 435.1.

1.1. Site and Facility Background

The INL Site is a DOE facility occupying approximately 2,305 km^2 (890 mi^2) of mostly undeveloped, high-desert terrain in southeastern Idaho (see Figure 1). The RHLLW Disposal Facility is located 0.48 km (0.3 miles) from the southwest corner of the Advanced Test Reactor (ATR) Complex (see Figure 2). The facility was designed to receive waste canisters generated at the ATR Complex, Naval Reactors Facility (NRF), and Materials and Fuels Complex (MFC) (see Table 1). All waste received at the RHLLW Disposal Facility will be permanently disposed of in stainless-steel canisters emplaced in precast concrete, below-grade disposal vaults. Each concrete vault consists of a hexagonal base with an integral riser, an upper riser section, and a removable vault shield plug for access and shielding. The vaults are arranged in four arrays by the waste canister type and size they will accept (see Figure 3).

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[3] The facility CA comprises the original CA (DOE/ID-11422, Revision 0) and the subsequently issued addendum (DOE/ID-11577, Revision 0). All references to the CA herein are intended to reflect the technical content of both documents.

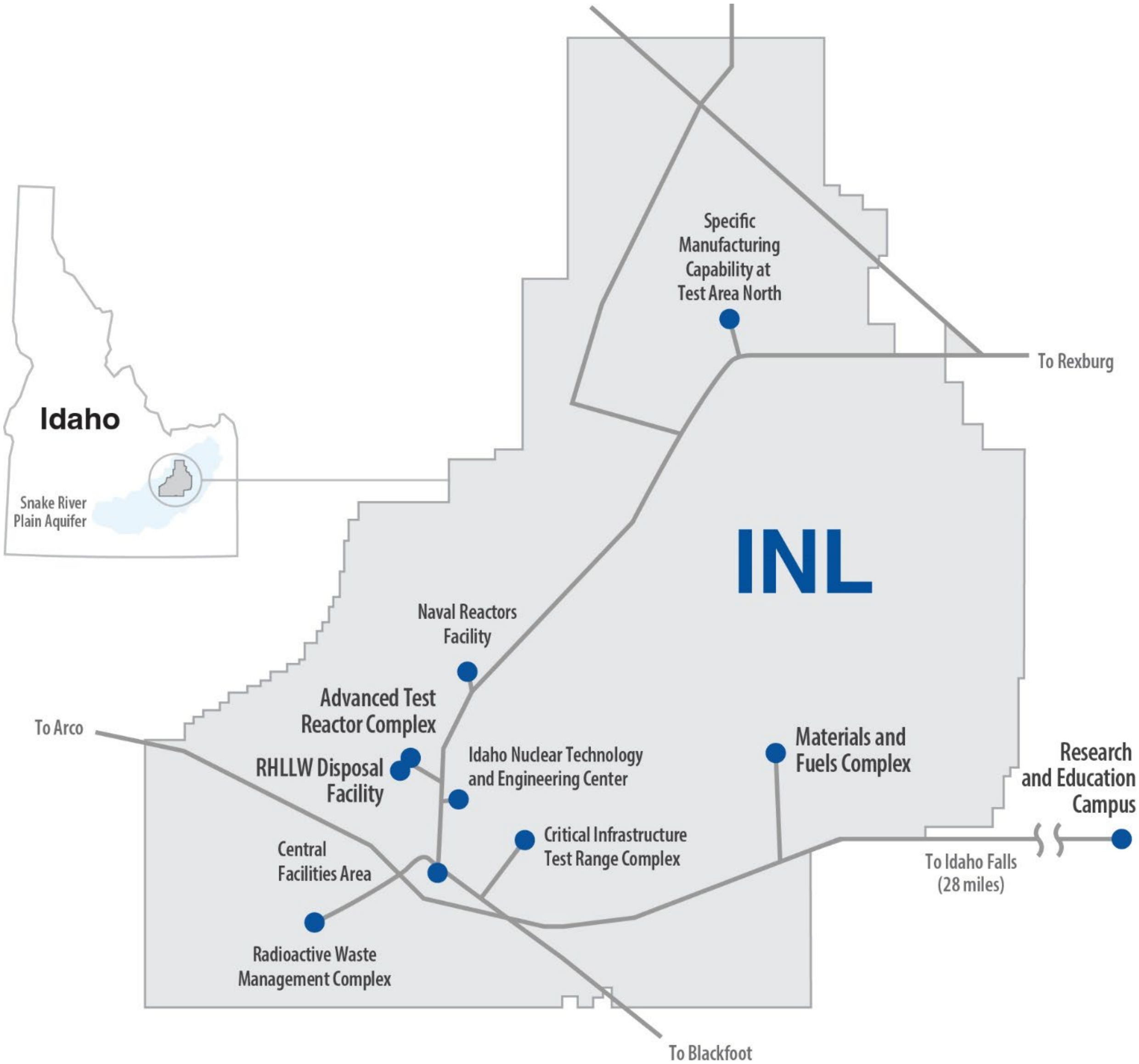

Figure 1. Map of INL Site showing the locations of major facilities, including the RHLLW Disposal Facility.

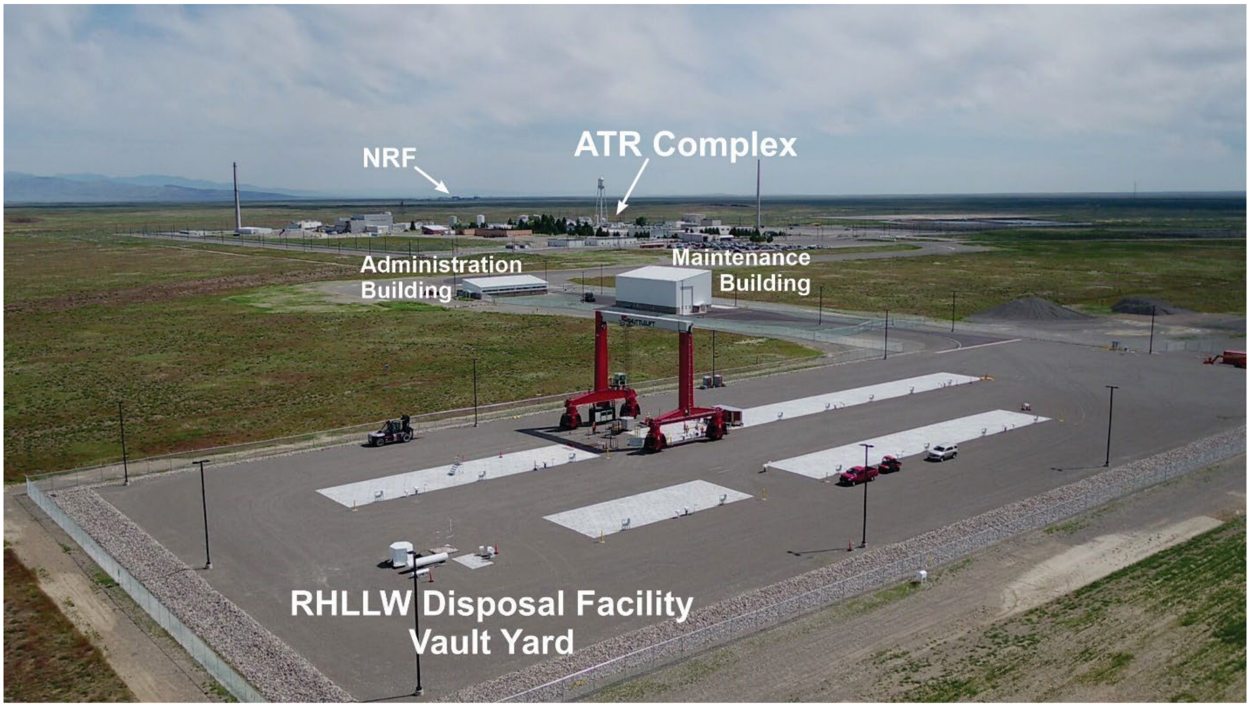

Figure 2. RHLLW Disposal Facility showing administration and maintenance building (background) and vault yard (foreground). The ATR Complex is in the background and NRF is in the far background.

Table 1. Waste cask/canister systems in use or planned for use at the RHLLW Disposal Facility.

Waste Generation Facility	Waste Canister Type	Waste Type	Array
ATR Complex	NuPac 14-210L Cask/Canisters	Ion-Exchange Resins	Array 1 (NuPac Vaults)
NRF	NFC[a] Canisters	Ion-Exchange Resins/ Activated Metals/Debris	Array 2 (NFC[a] Vaults)
NRF	55-ton Scrap Cask/Canisters	Ion-Exchange Resins/ Activated Metals/Debris	Array 3 (55-ton Vaults)
MFC	Modified Facility Transfer Container (MFTC)/Large Liners	Activated Metals/Debris	Array 4 (MFTC Vaults)
ATR Complex	ATR-5 Cask/Canisters	Activated Metals	Array 2 (HFEF Vaults)
MFC	Hot Fuel Examination Facility (HFEF)-5 Cask/Canisters	Activated Metals/Debris	Array 2 (HFEF Vaults)

a. Naval Spent Fuel Handling Facility Waste Cask (NFC) vaults and canisters are referred to in the PA and other technical-basis documents as large concept cask (LCC) vaults and canisters. The name LCC has been replaced with NFC.

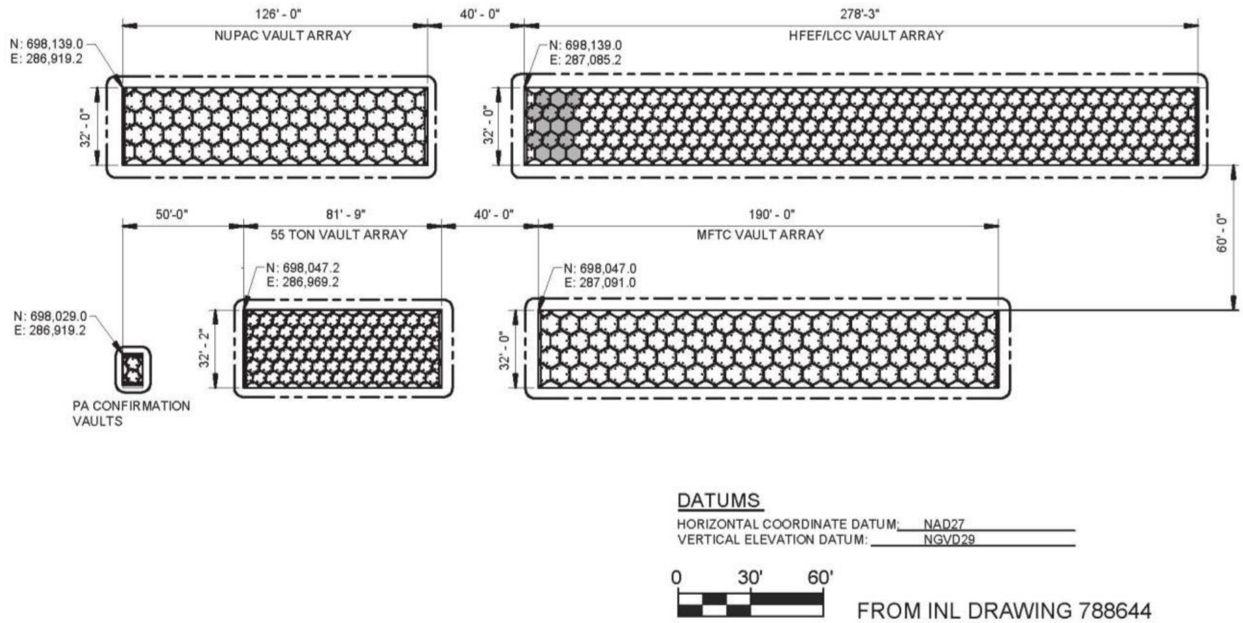

Figure 3. Horizontal layout of the disposal vault arrays at the RHLLW Disposal Facility. The LCC vault array has been renamed the NFC vault array.

1.2. Purpose and Scope

The purpose of this FY 2024 ASR is to summarize operations and activities conducted during the year in the context of modeling and the assumptions that form the basis for the conclusions of the PA and CA. This ASR evaluates the adequacy of the approved PA and CA and related documents, and it concludes FY 2024 RHLLW Disposal Facility operations were conducted within the bounds of the PA, CA, and ODAS. This ASR addresses RHLLW Disposal Facility operations for FY 2024 and includes an overview of PA- and CA-related activities for the RHLLW Disposal Facility in the same period.

The PLN-3368, "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis" (i.e., the PA/CA maintenance plan), describes the activities to be performed to maintain the PA and CA for the RHLLW Disposal Facility. The PA/CA maintenance plan specifies that the ASR will be prepared in accordance with Chapter 9 of

DOE-STD-5002-2017, "Disposal Authorization Statement and Tank Closure Documentation Technical Standard."

This FY 2024 ASR is based on requirements contained within all technical-basis documents associated with the PA and CA and provides the following information:

- Section 2—Summary of changes that could potentially impact the PA, CA, ODAS, or RWMB
- Section 3—Discussion of the cumulative effect of changes
- Section 4—Waste receipts, disposal capacity, key radionuclide inventories, and facility performance
- Section 5—Summary of facility, compliance, and performance monitoring
- Section 6—Research and development activities that might impact PA and CA results and conclusions
- Section 7—Planned or contemplated changes to the technical-basis documents

- Section 8—Status of the ODAS conditions and key and secondary issues
- Section 9—Annual determination of the continued adequacy of the PA and CA for FY 2024 based on summary information presented in this report.

2. CHANGES POTENTIALLY AFFECTING THE PA, CA, ODAS, OR RWMB

Nineteen waste canister disposals were performed in FY 2024 at the RHLLW Disposal Facility. This brings the total number of canister disposals to 89 by the end of FY 2024. There were no impacts to the RHLLW Disposal Facility PA, CA, ODAS, or RWMB resulting from operations or other activities in FY 2024.

Other than an update to the facility monitoring plan (see Table 2, UDQE-RHLLW-096), there were no updates to the PA, CA, ODAS, RWMB, or other technical-basis documents in FY 2024. Current versions of the technical-basis documents are as follows[4]:

- DOE/ID-11421, "Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 2.
- DOE/ID-11422, "Composite Analysis for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0.
- DOE/ID-11577, "Addendum to the Composite Analysis for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0.
- PLN-3368, "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," Revision 3.
- PLN-5501, "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 3.
- PLN-3370, "Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0.
- PLN-5503, "Addendum to the Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 0.
- PLN-5446, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2.
- RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Revision 1.

4 The ODAS incorrectly referenced all technical-basis documents as Revision 0. The approved versions of the documents at the time the ODAS was approved are confirmed in an email from S. Golian to J. Conner on May 24, 2018.

2.1. Unreviewed Disposal Question Screens and Evaluations

New proposed activities, changes in existing activities, facility configuration changes, or new information that could potentially impact the conclusions or assumptions of the PA and CA are evaluated using the facility change control process documented in RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility." As part of the process, several unreviewed disposal question screenings (UDQSs) and unreviewed disposal question evaluations (UDQEs) were performed to support operations in FY 2024. A summary of all UDQSs and UDQEs that were in progress at the end of FY 2023 or initiated in FY 2024 is provided in Table 2. All UDQS/UDQE forms completed and approved in FY 2024 are provided in Appendix A, "Fiscal Year 2024 Unreviewed Disposal Question Screenings and Evaluations for the RHLLW Disposal Facility."

Seven UDQS/UDQEs were in progress at the end of FY 2023, and 27 were initiated in FY 2024 for a total of 34. Of the 34 UDQS/UDQEs, two were screened negative and approved, three were in the process of being screened, and 29 were screened positive, requiring an evaluation. Of the 29 required evaluations, 28 were completed and determined to be negative, meaning the change, activity, or new information was determined to be within the bounds of the PA, CA, and ODAS. One evaluation was still in progress at the end of FY 2024.

Nineteen of 28 evaluations performed were for waste canisters with radionuclide inventories flagged by the RHLLW Inventory Online (RHINO[5]) software. Prior to shipment, waste canister details are entered into RHINO, which performs waste acceptance criteria (WAC) and PA checks to evaluate canisters for acceptance. WAC checks evaluate the radionuclide inventory of each canister against nuclear-safety threshold levels derived in Engineering Calculations and Analysis Report (ECAR)-1559, "Evaluation of Facility Inventory and Radiological Consequences to Support RHLLW Disposal Facility Safety Basis," and presented in the WAC (PLN-5446, Appendix A). If the canister inventory for one or more radionuclides exceeds a threshold level in Appendix A of the WAC, a full dose-consequence calculation must be completed to verify the total dose consequence is within the bounding total dose-consequence values evaluated for that canister type and waste stream. PA checks performed by RHINO compare the radionuclide inventory of each canister against threshold values or action levels or identify radionuclides not considered in the PA (DOE-ID 2018a). Canisters that are flagged by RHINO during PA checks must also be evaluated to determine whether the inventories and dose impacts are within the bounds of the PA.

Other evaluations addressed potential impacts from the following:

- Changes in DOE-STD-1196 (UDQE-RHLLW-057)
- Revised estimated inventory of radionuclides in NRF resins (UDQE-RHLLW-079)
- Idaho Nuclear Technology and Engineering Center (INTEC) Calcined Solids Storage Facility PA and CA (UDQE-RHLLW-080)
- Use of heaters during waste emplacement operations (UDQE-RHLLW-086)
- Proposed changes to the RHLLW Disposal Facility Monitoring Plan (UDQE-RHLLW-096)
- Damage to vault shield plugs (VSPs) or the Hot Fuel Examination Facility (HFEF) Cask-to-Vault Adapter System (CVAS) found during annual inspections (UDQE-RHLLW-065, -066, -072, -073, and -105).

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5 RHINO is an NQA-1 software application for accepting, managing, and tracking the receipt of waste and its disposal location (Section 4.3). The technical and functional requirements for RHINO are found in TFR-981, "Remote Handled-LLW Inventory Online Database."

In summary, it was determined there were no impacts to the PA, CA, ODAS, or RWMB based on the 30 UDQS/UDQEs completed and approved in FY 2024. The need for a special analysis or a determination of impacts to the PA, CA, ODAS, or RWMB, based on the other four UDQS/UDQEs still in progress at the end of FY 2024, is to be determined and will be reported in the FY 2025 ASR.

Table 2. Unreviewed disposal question screens and evaluations performed during FY 2024.

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-029	Disposal of irradiated metal shavings collected from sizing operations at ATR Complex	The ATR RHLLW project has designed and fabricated underwater cutting tools for waste sizing and packaging. The biproduct of sizing will generate metal shavings. Disposal of the shavings is currently being evaluated for potential pyrophoricity. Shavings will not be allowed in waste canisters until this issue is resolved and the UDQE approved.	Positive	In Progress	In Progress	TBD	TBD
UDQE-RHLLW-040	Inclusion of remote-handled hafnium waste from ATR canal	The ATR-Canal Cleanout Project requested the ability to strategically package and ship hafnium-waste components from the ATR canal to the RHLLW Disposal Facility for disposal. The PA model was based on a specific list of components from changeouts of the ATR core, and hafnium components were specifically excluded. The ATR-Canal Cleanout Project is exploring disposal options. Hafnium-waste components will not be allowed in waste canisters until this issue is resolved and the UDQE approved.	In Progress	TBD	TBD	TBD	TBD

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-057	Review DOE-STD-1196-2022 and evaluate potential impacts to the PA and CA	Dose coefficients from DOE-STD-1196-2011 (2011) were used for PA dose calculations in DOE-ID (2018a). The standard was revised in 2021 (DOE-STD-1196-2021) and again in 2022 (DOE-STD-1196-2022). Although these revisions do not require PA calculations be updated, the impact of new dose coefficients was evaluated for planning purposes. The evaluation determined the all-pathways dose would decrease 79% during the compliance period and 62% during the post-compliance period using updated dose coefficients. Other changes were noted.	Positive	Negative	Approved 10/5/23	N/A	None
UDQE-RHLLW-065	Vault shield plugs (VSPs) with Level 3 or greater damage identified during 2022 annual inspection	VSPs are inspected annually for damage. The 2022 inspection revealed damage (chips and cracks) to four VSPs: VSP-C1, VSP-D1, VSP-E1, and VSP-E2 in Vault Array 2. Damage and repairs are managed using the change control process. All four VSPs were determined to be operable with respect to the safety-significant component criteria of SAR-419. Repairs were successfully completed in FY 2023 under WO 332969. All four VSPs were determined to be operable with respect to the safety-significant component criteria of SAR-419.	Positive	Negative	Approved 12/13/23	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-066	Cask-to-Vault Adapter System (CVAS) exhibiting Level 3 or greater damage identified during 2022 annual inspection	The HFEF CVAS is inspected annually for damage. The 2022 inspection identified Level 3 or greater damage (chip and crack). Damage and repairs are managed using the change control process. Repairs were successfully completed in FY 2023 under WO 342641. The HFEF CVAS was determined to be operable with respect to the safety-significant component criteria of SAR-419.	Positive	Negative	Approved 12/13/23	N/A	None
UDQE-RHLLW-072	CVAS exhibiting Level 3 or greater damage identified during 2023 annual inspection	The HFEF CVAS is inspected annually for damage. The 2023 inspection identified Level 3 or greater damage (chip and cracks). Damage and repairs are managed using the change control process. Repairs were successfully completed in FY 2023 under WO 342641. The HFEF CVAS was determined to be operable with respect to the safety-significant component criteria of SAR-419.	Positive	Negative	Approved 12/13/23	N/A	None
UDQE-RHLLW-073	VSPs with Level 3 or greater damage identified during 2023 annual inspection	VSPs are inspected annually for damage. The 2023 inspection revealed damage (chips and cracks) to three VSPs: D2 in Array 2 and C4 and C5 in Array 3. Damage and repairs are managed using the change control process. Repairs were successfully completed in FY 2023 under WO 349402. All three VSPs were determined to be operable with respect to the safety-significant component criteria of SAR-419.	Positive	Negative	Approved 12/13/23	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-079	NRF new projected radionuclide inventory for resin modules with extended service life	NRF is proposing to extend the service life of Radioactive Water Demineralizer System modules in the Expended Core Facility (ECF) water pool and the Naval Spent Fuel Handling (NSFH) Facility water pool when it becomes operable. A new revised 20-year estimate of radionuclides on NRF resins was provided. An evaluation was conducted to determine the potential impact of the revised inventory estimate on the PA. It was determined the revised inventory is within the bounds of the PA.	Positive	Negative	Approved 9-30-24	N/A	None
UDQE-RHLLW-080	Potential impact of INTEC Calcined Solids Storage Facility PA and CA on the RHLLW Disposal Facility CA	During preparation of the RHLLW Disposal Facility CA (DOE/ID-11422, 2012), radioactive calcined waste stored in stainless-steel tanks at the INTEC Calcined Solids Storage Facility (CSSF) was not considered a viable source because information did not exist to develop a realistic and reliable source term. The CSSF PA and CA were recently completed (DOE-ID, 2022) documenting the impacts of residual radioactive calcined waste that may remain after the bulk of the waste is retrieved from the CSSF. This UDQE reviewed the CSSF CA for potential impacts to the RHLLW CA and concluded the CSSF dose contributions are insignificant and cannot have a significant impact on any other LLW disposal facilities or remediation decisions at the INL Site.	Negative	N/A	Approved 11-6-23	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-081	Canister ECF-05-18-118 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-05-18-118) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 10-19-23	N/A	None
UDQE-RHLLW-082	Canister ECF-01-21-114 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-114) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 11-1-23	N/A	None
UDQE-RHLLW-083	Canister ECF-05-18-113 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-05-18-113) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 11-15-23	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-084	Canister ECF-05-18-105 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-05-18-105) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 12-6-23	N/A	None
UDQE-RHLLW-085	Canister ECF-01-21-105 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-105) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 1-10-24	N/A	None
UDQE-RHLLW-086	Use of heaters on VSPs during waste emplacement operations	Use of heaters to melt snow and ice on VSP surfaces prior to waste emplacement operations to create a safer work environment was considered. An evaluation determined use of heaters would not result in undue damage to the VSP concrete, and the use of an Allmand Maxi-Heat mobile diesel-fueled heater (or similar type equipment) was deemed acceptable for heating VSPs, provided the heater is operated in a manner similar to the testing described in the UDQE.	Positive	Negative	Approved 2-8-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-087	Canister ECF-01-21-103 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-103) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 2-1-24	N/A	None
UDQE-RHLLW-088	ATR-5 Canister 814600-13 from ATR Complex flagged by RHINO during acceptance testing	An ATR-5 waste canister from the ATR Complex (816400-13) that contains activated metals and surface contamination was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 2-14-24	N/A	None
UDQE-RHLLW-089	Canister ECF-01-21-109 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-109) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 2-15-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-090	HFEF-5 Canister MFC240072 from MFC flagged by RHINO during acceptance testing	A new-generation (non-legacy) HFEF-5 waste canister from MFC (MFC240072) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 3-13-24	N/A	None
UDQE-RHLLW-091	Canister ECF-01-21-111 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-111) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 4-9-24	N/A	None
UDQE-RHLLW-092	Canister ECF-01-21-106 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-106) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 4-17-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-093	NRF Request for Exception to Reswipe Canister ECF-01-21-106	NRF requested a one-time exception for canister ECF-01-21-106 to exceed by two days a requirement to load the canister within two weeks of swiping, without having to reswipe, and reanalyze prior to loading. The two-week requirement was a condition that came from a special analysis to address a request by NRF for an exemption to limits of removable contamination on canister exteriors. An evaluation determined it is unlikely the exterior contamination on canister ECF-01-21-106 is greater than WAC limits, and NRF's request for a one-time exception is reasonable and acceptable, provided certain conditions were met. It was confirmed the conditions were met, and the exemption was granted.	Positive	Negative	Approved 5-2-24	N/A	None
UDQE-RHLLW-094	Canister ECF-01-21-104 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-104) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 5-21-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-095	ATR-5 Canister 814600-15 from ATR Complex flagged by RHINO during acceptance testing	An ATR-5 waste canister from the ATR Complex (816400-15) that contains activated metals and surface contamination was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 5-20-24	N/A	None
UDQE-RHLLW-096	Proposed changes to RHLLW Disposal Facility Monitoring Plan (PLN-5501)	All proposed changes to technical-basis documents are evaluated through the change control process to determine potential impacts to the PA and CA. Several changes to the RHLLW Disposal Facility Monitoring Plan were proposed based on information collected during the first four years of operations. A screening evaluation determined the proposed changes do not affect the assumptions and/or conclusions of the PA/CA. No further action required.	Negative	N/A	Approved 9-26-24	N/A	None
UDQE-RHLLW-097	Canister ECF-05-18-119 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-05-18-119) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 5-30-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-098	ATR-5 Canister 814600-12 from ATR Complex flagged by RHINO during acceptance testing	An ATR-5 waste canister from the ATR Complex (816400-12) that contains activated metals and surface contamination was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 6-25-24	N/A	None
UDQE-RHLLW-099	Canister ECF-01-21-129 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-129) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 7-9-24	N/A	None
UDQE-RHLLW-100	Proposed changes to the Waste Acceptance Criteria (PLN-5446)	Tables in Appendix B of the WAC will be updated to include radionuclides identified in various waste streams that were not evaluated in the PA. The impact of these radionuclides were evaluated (see UDQE-RHLLW-052, UDQE-RHLLW-079, and UDQE-RHLLW-088) and determined to be within the bounds of the PA. The UDQE will evaluate these changes and identify any other updates or changes that must be made.	In Progress	TBD	TBD	TBD	TBD

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-101	Canister ECF-01-21-122 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-122) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 8-12-24	N/A	None
UDQE-RHLLW-102	Canister ECF-01-21-110 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-01-21-110) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 9-4-24	N/A	None
UDQE-RHLLW-103	Canister ECF-05-18-109 from NRF flagged by RHINO during acceptance testing	A 55-ton waste canister from NRF (ECF-05-18-109) that contains activated metals and surface-contaminated debris was flagged by RHINO while performing PA checks during acceptance testing. Radionuclide inventories were evaluated, and impacts were determined to be small and within the bounds of the PA. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved 9-19-24	N/A	None

UDQS/UDQE Identification Number[a]	Subject	Description and Screen/Evaluation Results	UDQS Result	UDQE Result	UDQE Status	Special Analysis (if Applicable)	PA, CA, ODAS or RWMB Impacts[b]
UDQE-RHLLW-104	VSPs with Level 3 or greater damage identified during 2024 annual inspection	VSPs are inspected annually for damage. The 2024 inspection revealed damage (chips and cracks) to four VSPs: D1 and D2 in Array 2 and E10 and F11 in Array 3. Damage and repairs are managed using the change control process. Repairs will be completed in FY 2025 per WO 372323, and the UDQE will be processed accordingly. All four VSPs were determined to be operable with respect to the safety-significant component criteria of SAR-419.	In Progress	TBD	TBD	TBD	TBD
UDQE-RHLLW-105	CVAS exhibiting Level 3 or greater damage identified during 2024 annual inspection	The HFEF CVAS is inspected annually for damage. The 2024 inspection identified Level 3 or greater damage (chip and cracks). Damage and repairs are managed using the change control process. Repairs were successfully completed under WO 364224 in FY 2024. The HFEF CVAS was determined to be operable with respect to the safety-significant component criteria of SAR-419.	Positive	Negative	Approved 9-28-24	N/A	None

a. N/A indicates an evaluation was not required due to a negative screen.

b. UDQES/UDQEs are presented sequentially without regard to status. Identification numbers missing from the sequence were completed in a previous FY.

c. “None” includes impact determination described as minimal, insignificant, not-discernable, etc.

2.2. Land-Use Plans for the INL Site

Land use at the INL Site is currently managed by the management and operations contractor, Battelle Energy Alliance, LLC (BEA), in collaboration with DOE Idaho Operations Office (DOE-ID) (Charter [CTR]-274). The primary use of INL Site land is to support DOE Nuclear Energy (DOE-NE) activities focused on nuclear energy research, sustainable energy systems, and National and Homeland Security missions; DOE Environmental Management (DOE-EM) activities focused on legacy-waste management, spent nuclear fuel management, and environmental remediation of contaminated waste sites; and the Naval Nuclear Propulsion Program's mission to manage naval spent fuel. Land use for the INL Site is described in the "INL Comprehensive Land Use and Environmental Stewardship" (CLUES) report update (INL 2024a), and the "INL Site-Wide Institutional Controls, and Operations and Maintenance Plan for CERCLA Response Actions" (DOE-ID 2024). The RHLLW Disposal Facility and associated long-term controls were incorporated into the previous revision of the CLUES report (INL 2022b). A review of the previous CLUES report was conducted in FY 2022 (see INL 2023a: Table 2, UDQE-RHLLW-056), and determined land-use activities, planning, and decisions described in the report are consistent with the assumptions in the RHLLW Disposal Facility PA, CA, and closure plan. The CLUES report was revised in September 2024 and will be reviewed in FY 2025 along with DOE-ID (2024) for potential impacts to the PA, CA, and closure plan.

Recent congressional actions,[6] proposed congressional actions, presidential executive orders,[7] DOE-ID site-use permits,[8] construction of new nuclear energy research infrastructure at INL, and DOE's Cleanup to Clean Energy initiative[9] may result in private energy generation and private nuclear energy research and development, as well as ongoing DOE-generated RHLLW. These will be evaluated as projects are announced and as more information becomes available.

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6 Public Law 115-248, September 28, 2018, *Nuclear Energy Innovation Capabilities Act (NEICA) of 2017*, which amends the *Energy Policy Act of 2005* revising objectives for civilian nuclear energy research development, demonstration, and commercial application programs of the DOE to emphasize research infrastructure and enable private-sector partnerships with national laboratories to demonstrate novel reactor concepts. The Act created the National Reactor Innovation Center (NRIC) for DOE-Nuclear Energy. NRIC is led by INL and provides access and resources to private-sector technology developers for testing, demonstration, and performance assessment to accelerate deployment of new advanced nuclear technology concepts.

Public Law 115-439, January 14, 2019, *Nuclear Energy Innovations and Modernization Act (NEIMA)*, which requires the Nuclear Regulatory Commission (NRC) to develop regulation for advanced nuclear reactor technologies. These technologies may be developed/tested at INL under DOE, Department of Defense, or NRC rules.

Public Law 118-67, July 9, 2024, *Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act)*, modifies existing requirements and imposes new statutory requirements affecting advanced nuclear power, including American nuclear leadership, developing and deploying new nuclear technologies, preserving existing nuclear energy generation, and nuclear fuel cycle, supply chain, infrastructure, and workforce. These changes have the potential to impact existing or future projects at INL.

7 See, e.g., Executive Order 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability," 86 Fed. Reg. 70935 (Dec. 13, 2021).

8 Use Permit No. DE-NE700105, Use Permit Authorized by US DOE to Oklo, Inc (2019).

9 See Cleanup to Clean Energy – Expanding Clean Energy Generation on DOE Lands, https://www.energy.gov/management/osp/cleanup-clean-energy-expanding-clean-energy-generation-doe-lands.

Development-forecast planning for land use assumes that key areas of the INL Site, including the ATR Complex, will remain under government control in perpetuity with no new private developments (residential or nonresidential) in areas adjacent to the INL Site. Future land use during the 1,000-year compliance period is expected to remain essentially the same, as described in the previous CLUES report (INL 2022b). Future land use identified in the PA, CA, and closure plan is consistent with land-use plans described in the previous CLUES report (INL 2022b). The 2024 update of the CLUES report will be reviewed in FY 2025 to ensure no changes are needed to ensure the continued adequacy of the PA, CA, and closure plan with respect to land-use assumptions.

2.3. Waste Acceptance Criteria

Only RHLLW in approved stainless-steel waste canisters is accepted for disposal in the concrete vaults at the RHLLW Disposal Facility. PLN-5446, referred to as the WAC, specifically addresses the acceptance of RHLLW. No other waste is addressed in the WAC or will be accepted in the future. The WAC was originally issued in FY 2018. It was revised in FY 2023 to update acceptable limits for surface contamination for NRF waste canisters (see Section 2.7). The WAC will be revised in FY 2025 to include additional radionuclides identified as surface contamination in NRF and ATR Complex waste streams (see Table 2, UDQE-RHLLW-100).

2.4. Impact of Future Disposals

Nineteen waste canister disposals were performed in FY 2024 at the RHLLW Disposal Facility. The facility is expected to operate for many more years and will continue to accept waste from the ATR Complex, NRF, and MFC, as stated in Section 1.1. Future disposals are expected to be within the constraints of the ODAS (ODAS 2018).

2.5. Composite Analysis Inventory and Waste Form

Sources of contamination considered in the CA are still valid, and no new significant sources have been identified. The PA and CA for the INTEC Calcined Solids Storage Facility (located 3.2 km ESE of the RHLLW Disposal Facility) was approved by the DOE Low-Level Waste Disposal Facility Federal Review Group (LFRG) in FY 2023 (DOE-ID 2022). That information was reviewed in FY 2024 to determine potential impacts on the RHLLW Disposal Facility's CA (see Table 2, UDQE-RHLLW-080). The review determined there is no significant impact from the Calcined Solids Storage Facility closure on the RHLLW Disposal Facility CA.

The PA/CA maintenance plan (PLN-3368) includes a requirement to evaluate the potential impact of published INL Site Comprehensive Environment Response, Compensation, and Liability Act (CERCLA) 5-year reviews on the PA and CA, including review of upgradient- groundwater monitoring data. The most recent 5-year review of CERCLA response actions for the INL Site was published in 2021 and addressed FYs 2015–2019 (DOE-ID 2021). A review of DOE-ID (2021) was conducted in FY 2022 and found no information that could potentially impact the validity or conclusions of the RHLLW Disposal Facility PA or CA (see Table 2, UDQE-RHLLW-055).

2.6. Interim and Final Closure

The preliminary closure plan (PLN-3370) and closure plan addendum (PLN-5503) outline the timeline and general procedure for the closure of the RHLLW Disposal Facility. When used together, PLN-3370 and PLN-5503 form the closure basis for the facility. The plans will be updated as necessary during the operational phase of the facility in response to changes in operations, information developed from monitoring data, and/or improved understanding of RHLLW Disposal Facility performance.

As specified in the closure plan addendum, no interim or operational closure is planned. An interim closure cover is not required to meet vault-system design performance. Installation of an interim cover would require development of an interim closure plan for the facility and evaluation in accordance with the facility change control process (RH-ADM-5214).

Final closure of the RHLLW Disposal Facility will be conducted at the end of the operational life of the facility in accordance with a final closure plan that meets the requirements of DOE Order 435.1. A final PA and CA will be prepared after the end of operations in support of facility closure. Revisions to the PA will provide final disposal inventories and any updates in parameter values based on research and monitoring results. The final closure plan will specify steps to be taken to ensure long-term stability of the facility and the INL Site, as well as any ongoing maintenance and monitoring activities to be performed during the period of institutional control.

2.7. Special Analyses and Reviews

Special analyses for the RHLLW Disposal Facility are used to evaluate special-case waste disposals and to evaluate changes at the INL Site that could affect the PA or CA conceptual models and, potentially, the results of the PA and CA. The WAC allows for special-case disposals on a case-by-case basis after a documented request for deviation and subsequent approval of a special analysis. In FY 2024, no special-case disposals were required, and no special analyses were conducted.

2.8. Other Relevant Factors—Design and Operations

Other relevant factors to be considered regarding the adequacy of the PA and CA include operational and design considerations. During FY 2024, there were no changes in the design, construction, or operation of the RHLLW Disposal Facility that were not considered in the PA or CA. While the commencement of shipment and disposal of ATR-5 waste canisters from the ATR Complex in FY 2024 constitutes a change in daily operations at the facility, this activity was anticipated and considered during PA and CA preparation. Therefore, it has no impact on the adequacy of the PA or CA.

2.9. Other Maintenance Activities

Maintenance activities for the RHLLW Disposal Facility are delineated in PLN-3368, Revision 3. The plan addresses both physical preventative and corrective maintenance at the facility, as well as maintenance of the PA, CA, RWMB, and ODAS.

2.9.1. Planned Evaluations and Reviews

In accordance with the RHLLW Disposal Facility WAC (PLN-5446), facility evaluations (FEs) of waste generators are performed as part of the initial and annual certification process, according to MCP-4211, "Conduct of RHLLW Disposal Facility Waste Generator Facility Evaluations." FEs are conducted to ensure each generator's waste certification program and waste streams are compliant with WAC by evaluating and measuring the adequacy of processes and their implementation and by identifying conditions adverse to quality.

Successful recertifications for approved waste generators MFC (ASMT-2024-0423) and NRF (ASMT-2024-0422) were conducted in FY 2024. An initial waste-generator certification of ATR Complex Waste Programs began in FY 2023 and was successfully completed in FY 2024. (ASMT-2024-0106). The first waste shipment from ATR Complex occurred in February 2024.

In addition to FEs, PLN-3368 includes a list of other evaluations and reviews to be conducted annually to support preparation of the ASR. These include the following:

- Evaluate changes to dose coefficients (DOE-STD-1196)
- Evaluate changes to DOE Order 458.1, "Radiation Protection of the Public and the Environment"
- Evaluate changes to DOE Order 435.1, "Radioactive Waste Management"
- Evaluate changes to state of Idaho groundwater quality regulations

- Review waste disposal records
- Review air-emissions projections based on current inventory
- Review groundwater-pathway compliance and performance-monitoring data
- Review onsite (i.e., on INL Site) air-monitoring data
- Review hydraulic drainage system performance data.

There were no changes to any of the DOE standards, orders, or other regulations from the above list in FY 2024.

Regarding required reviews, a summary and review of waste disposal records is presented and discussed in Section 4. Groundwater-pathway compliance and performance-monitoring data are presented and reviewed in Section 5. A review of onsite INL Site air-monitoring data is performed annually and discussed in Section 5. Air emissions are not reported from the facility because the air pathway was screened from the PA, and no regulated emissions are expected. However, air-pathway doses are calculated and updated by RHINO as part of the acceptance process for each waste canister (see Section 4.4). Hydraulic drainage system performance data were not available in FY 2024 due to technical issues with the laptop that communicates with the data loggers. Typically, water content data are the only hydraulic drainage system data that are reviewed annually, which is only done to support the timing of lysimeter sampling efforts. The lack of data access, however, is not viewed as problematic because sampling experience during the first four years of operations has shown that location is a better indicator of water availability than the time of year as long as sampling occurs in the spring after the majority of the snow has melted (INL 2023b).

2.9.2. Documentation Updates

Table 1 of the PA/CA maintenance plan (PLN-3368) lists requirements for documentation updates, as necessary. There are no ODAS conditions or limitations that were not closed as part of the LFRG review of the PA and CA that require tracking. Technical-basis documents that have been revised since issuance of the ODAS include the monitoring plan (PLN-5501) in FY 2020 and FY 2024, the PA/CA maintenance plan (PLN-3368) in FY 2021, the change control process document (RH-ADM-5214, formerly SD-52.1.4) in FY 2022 and FY 2024, and the WAC (PLN-5446) in FY 2023.

The monitoring plan was updated in FY 2024 to make several changes based on information collected while monitoring the facility during the first four years of operations (INL 2023b). The changes were evaluated in UDQE-RHLLW-096 (see Table 2) and include the following:

- Revise the gross-alpha action level for lysimeter samples during post-baseline monitoring phase from 10 to 20 pCi/L, and add tritium to analyte list
- Revise lysimeters to be sampled and response actions for the post-baseline monitoring phase
- Revise schedule/conditions for post-baseline monitoring phase annual lysimeter sampling
- Revise compliance (aquifer) sampling response actions for exceedance of lysimeter action level.

The change control document RH-ADM-5214 was updated in FY 2024 to remove FRM-2544 from the list of documents requiring mandatory screening. UDQE-RHLLW-058 (see INL 2024b) recommended that FRM-2544 be removed from the list of documents requiring mandatory screening (UDQS) because forms do not and will not include new proposed activities, changes in existing activities, facility configuration changes, or new information that could potentially affect the assumption and/or conclusions of the PA or CA.

The only update planned for technical-basis documents in FY 2025 is an update to the WAC (PLN-5446). Tables in Appendix B of the WAC will be updated to include new radionuclides identified on NRF surface-contaminated debris (see INL 2023a: Table 2, UDQE-RHLLW-052), NRF resins (see

Table 2, UDQE-RHLLW-079), and activated metals (AMs) from ATR Complex (see Table 2, UDQE-RHLLW-088). This change is discussed in more detail in Section 7.

As discussed in Section 2.2, the recently revised CLUES report (INL 2024a) and the "INL Site-Wide Institutional Controls, and Operations and Maintenance Plan for CERCLA Response Actions" (DOE-ID 2024) will be reviewed in FY 2025 for potential impacts to the PA, CA, and closure plan.

2.9.3. Planned and As-Needed Maintenance Activities

Table 1 of the PA/CA maintenance plan (PLN-3368) lists other PA/CA maintenance activities required on a planned (annual inspections or preventative maintenance [PM]) and as-needed (corrective maintenance) basis.

2.9.3.1. Planned Maintenance Activities

Annual inspection (and maintenance as necessary) of vault-yard apron slopes that promote water runoff and form the flood-water berm of the facility has been established as a preventative maintenance (PM) activity directed by Model Work Order (MWO) 260064 (2018). The 2024 inspection was performed under annual Work Order (WO) 362249 (2024). Inspection of the vault-yard area showed typical rutting, settling, erosion, and some uneven surfaces in both the vault yard and in the apron; however, all were deemed not so significant in nature as to require immediate corrections and are expected for gravel surfaces over time, especially in industrial areas where heavy equipment is being operated. The vault-yard area and side slopes were also visually inspected for the presence of vegetation and animals or their nests or burrows. There was no indication of animal nesting. Some minor vegetation was present, which was removed immediately or sprayed with weed control chemicals by maintenance personnel. In addition, 16 random locations throughout the vault yard near the vault arrays were tested for compaction. All samples met or exceeded the required 95% compaction criteria.

A 3-year vault yard PM inspection was scheduled for 2024 per WO 359536. The scope of this inspection includes a topographic survey of the vault yard, and elevation measurements of 10% of VSP tops. The inspection is expected to be complete early in FY 2025.

VSPs are also inspected annually for damage per MWO 257898 (2018). The scope of the annual inspection requires the top surfaces of all VSPs on vaults that contain waste, as well as the top surfaces of VSPs on empty vaults adjacent to those with waste emplaced in them, to be inspected. The repair WOs direct qualified individuals to perform repairs followed by documented inspections by a qualified quality inspector to ensure these corrective-maintenance actions are completed properly and the VSP no longer exhibits issues that meet or exceed need-to-repair criteria.

The 2024 annual inspection was performed under WO 364089 (2024). VSPs D1 and D2 in Vault Array 2 and VSPs E10 and E11 in Vault Array 3 were identified as failing inspection criteria. These damages are typical superficial cracks and chips that do not expose rebar and are relatively shallow in nature. Operability Review OPR 2024-0294 evaluated these damages with respect to safety-analysis requirements in SAR-419 (2020) requirement and found all four VSPs can perform their safety function. Even though the four VSPs were declared acceptable for continued use, repairs will be performed under the routine repair WO 372323 to ensure VSPs can be expected to provide protection against water ingress into the steel reinforcement material and result in no impact to long-term vault performance. Repairs are scheduled for early FY 2025.

Table 1 of the PA/CA maintenance plan (PLN-3368) also identifies annual inspection (and maintenance, as necessary) of INL flood-protection measures, which supports a key assumption in the PA. During the spring and fall of each calendar year, each of the INL floodgates relevant to the RHLLW Disposal Facility are inspected, and PM activities are performed. Each floodgate and diversion dam was inspected in the fall of 2023 and the spring of 2024. During each inspection, routine PM was performed, and no major issues were identified. The inspections and PM of the diversion dams and floodgates were addressed under the following WO packages:

- PM Radioactive Waste Management Complex Diversion Dam Semiannual Floodgate Inspection (WO Package 349244, 2023), performed September 2023
- PM Radioactive Waste Management Complex Diversion Dam Semiannual Floodgate Inspection (WO Package 358796, 2024), performed March 2024
- PM Experimental Breeder Reactor-II Semiannual Floodgate Inspection (WO Package 350961, 2023), performed October 2023
- PM Experimental Breeder Reactor-II Semiannual Floodgate Inspection (WO Package 360679, 2024), performed April 2024
- PM Lost River Sinks Semiannual Floodgate Inspection (WO Package 350968, 2023), performed October 2023
- PM Lost River Sinks Semiannual Floodgate Inspection (WO Package 360672, 2024), performed April 2024
- PM Howe Semiannual Pole Line Road Floodgate Inspection (WO Package 350969, 2023), performed October 2023
- PM Howe Semiannual Pole Line Road Floodgate Inspection (WO Package 360673, 2024), performed April 2024.

The PA/CA maintenance plan further requires an annual evaluation of the potential impacts of proposed new facilities/projects with respect to the creation of perched water beneath the RHLLW Disposal Facility. Projects at the nearby ATR Complex that were initiated or continued in FY 2024 were evaluated. These include the following:

- Completion of construction of the ATR Reactor Support Building, which is a general office building with a cafeteria
- Completion of the ATR Parking Lot Refurbishment and Expansion.

Each of the construction projects incorporate general stormwater management features such as swales, ponds, or drainage basins for runoff control. The largest contributor to the perched water body below the ATR Complex is the Cold Waste Pond. The total FY 2024 discharge was within both the historical operational discharges and the facility's wastewater reuse permit limit (report year November–October) issued by Idaho Department of Environmental Quality. Therefore, the evaluation concluded that the impacts are insignificant regarding the creation of perched water beneath the RHLLW Disposal Facility.

2.9.3.2. As-Needed Maintenance Activities

As-needed maintenance activities that have not previously been addressed include maintenance actions for the facility monitoring system and the facility inventory management system. In FY 2024, the laptop that communicates with the data loggers, which collects and stores soil temperature, soil moisture, and soil water tension at the vault yard, was replaced. Efforts to link data loggers to the new laptop are ongoing and expected to be completed in FY 2025. Currently, moisture-content data are used only to support lysimeter sampling, but doing so is not required. No other corrective maintenance items were identified in FY 2024.

3. CUMULATIVE EFFECTS OF CHANGES

As described in Section 2, there were no changes identified in FY 2024 that impact assumptions and conclusions of the PA and CA or impact the validity of the RWMB and ODAS. Therefore, there are no cumulative effects from the changes identified in Section 2.

4. WASTE CERTIFICATION AND RECEIPTS

4.1. Waste Certification

In accordance with the RHLLW Disposal Facility WAC (PLN-5446), annual FEs (see Section 2.9.1) are conducted according to MCP-4211 (2020) to initially certify or recertify waste certification programs and waste streams are compliant with the WAC (PLN-5446). In FY 2024, ATR received initial certification (ASMT-2024-0106), and NRF (ASMT-2024-0422) and MFC (ASMT-2024-0423) were recertified.

As a result, current waste streams approved for shipment and disposal to the RHLLW Disposal Facility are as follows:

- AMs in ATR-5 canisters from ATR Complex
- AMs and surface-contaminated (SC) debris in HFEF-5 canisters from MFC
- AMs and SC debris in 55-ton canisters from NRF.

4.2. Waste Receipts

During FY 2024, 19 waste canisters were disposed of at the RHLLW Disposal Facility. Table 3 contains information on these 19 canisters, including container type, waste form, disposal date, and disposal location.

Table 3. Waste receipts and disposals in FY 2024.

Generator	Generator Canister ID No.	Container Type	Waste Form[a]	Shiptask No.	Receipt Date	Disposal Date	Vault Array	Disposal Position
NRF	ECF-05-18-120	55-ton	Combined	RHLLW-NRF-23-006	9/27/23	10/3/23	03	03-F07-1b (Top)
NRF	ECF-05-18-118	55-ton	Combined	RHLLW-NRF-24-001	10/23/23	10/23/23	03	03-F01-1a (Bot)
NRF	ECF-01-21-114	55-ton	Combined	RHLLW-NRF-24-002	11/6/23	11/7/23	03	03-F01-1b (Top)
NRF	ECF-05-18-113	55-ton	Combined	RHLLW-NRF-24-003	11/27/23	11/28/23	03	03-F08-1a (Bot)
NRF	ECF-05-18-105	55-ton	Combined	RHLLW-NRF-24-004	12/11/23	12/14/23	03	03-F08-1b (Top)
NRF	ECF-01-21-105	55-ton	Combined	RHLLW-NRF-24-005	1/25/24	1/29/24	03	03-F02-1a (Bot)
NRF	ECF-01-21-103	55-ton	Combined	RHLLW-NRF-24-006	2/8/24	2/14/24	03	03-F02-1b (Top)
ATR	814600-13	ATR-5	AM	RHLLW-ATR-24-001	2/15/24	2/19/24	02	02-D03-3b (Top)
NRF	ECF-01-21-109	55-ton	Combined	RHLLW-NRF-24-007	3/12/24	3/13/24	03	03-F09-1a (Bot)
MFC	MFC240072	HFEF-5	Combined	RHLLW-MFC-24-001	3/28/24	4/1/24	02	02-D03-4a (Bot)
NRF	ECF-01-21-111	55-ton	Combined	RHLLW-NRF-24-008	4/16/24	4/17/24	03	03-F03-1a (Bot)
NRF	ECF-01-21-106	55-ton	Combined	RHLLW-NRF-24-009	5/13/24	5/15/24	03	03-F10-1a (Bot)
ATR	814600-15	ATR-5	AM	RHLLW-ATR-24-002	5/22/24	5/23/24	02	02-D03-4b (Top)
NRF	ECF-01-21-104	55-ton	Combined	RHLLW-NRF-24-010	5/23/24	5/28/24	03	03-F04-1a (Bot)
NRF	ECF-05-18-119	55-ton	Combined	RHLLW-NRF-24-011	6/6/24	6/25/24	03	03-F04-1b (Top)
ATR	814600-12	ATR-5	AM	RHLLW-ATR-24-003	6/26/24	6/26/24	02	02-D03-5a (Bot)
NRF	ECF-01-21-129	55-ton	Combined	RHLLW-NRF-24-012	7/29/24	7/29/24	03	03-F09-1b (Top)
NRF	ECF-01-21-122	55-ton	Combined	RHLLW-NRF-24-013	8/19/24	8/19/24	03	03-F03-1b (Top)
NRF	ECF-01-21-110	55-ton	Combined	RHLLW-NRF-24-014	9/9/24	9/10/24	03	03-F10-1b (Top)
AM = Activated Metals, SC = Surface-Contaminated Debris, Combined = Activated Metals and Surface-Contaminated Debris.								

A summary of the canisters emplaced and facility capacity are presented in Table 4 This contains the vault capacity, the total vaults/positions filled through FY 2024, and the percentage of vaults/positions filled. The location of all canister placements through FY 2024 is shown in Figure 4. Table 5 contains a summary of the volume of canisters emplaced in the vaults.

Table 4. Vault capacity summary through FY 2024.

Vault Array	Vault Type	Vault Description	Positions Filled FY 2024	Positions Filled Cumulative Through FY 2024	Empty Positions Remaining Through FY 2024	Total Positions	Percent Positions Filled Through FY 2024
01	NuPac	1 Hole (2 Levels)	0	0	120	120	0.0%
02	HFEF-5	6 Holes (2 Levels)	4	69	111	180	38.3%
	NFC	1 Hole (Single Storage)	0	0	195	195	0.0%
03	55-ton	1 Hole (2 Levels)	15	20	148	168	11.9%
04	Modified FTC	3 Holes (1 Level)	0	0	276	276	0.0%
		Facility Total	19	89	850	939	9.48%

Table 5. Emplaced canister volume summary through FY 2024.

Vault Array	Vault Type	Canister Type, Generator, Waste Form	Generator	Gross Volume (m^3) FY 2024	Cumulative Gross Volume (m^3) Through FY 2024
02	HFEF-5	ATR-5 - ATR AMs w/ steel plug	ATR	0.72	0.72
		HFEF-5 – MFC AMs w/ lead plug	MFC	0	0.46
		HFEF-5 – MFC AMs w/ steel plug	MFC	0.15	4.31
		HFEF-5 – MFC Combined w/ lead plug[a]	MFC	0	0.62
		HFEF-5 – MFC Combined w/ steel plug[a]	MFC	0	3.54
		HFEF-5 – MFC Surface Contaminated w/ lead plug	MFC	0	0.15
		HFEF-5 – MFC Surface Contaminated w/ steel plug	MFC	0	1.08
		Vault Array Total		0.87	10.9
03	55-ton	NRF 55-ton Canister – AMs	NRF	41.6	55.5
		Vault Array Total		41.6	55.5
		Facility Total		42.5	66.4

a. Waste form is combined AMs and SC debris.

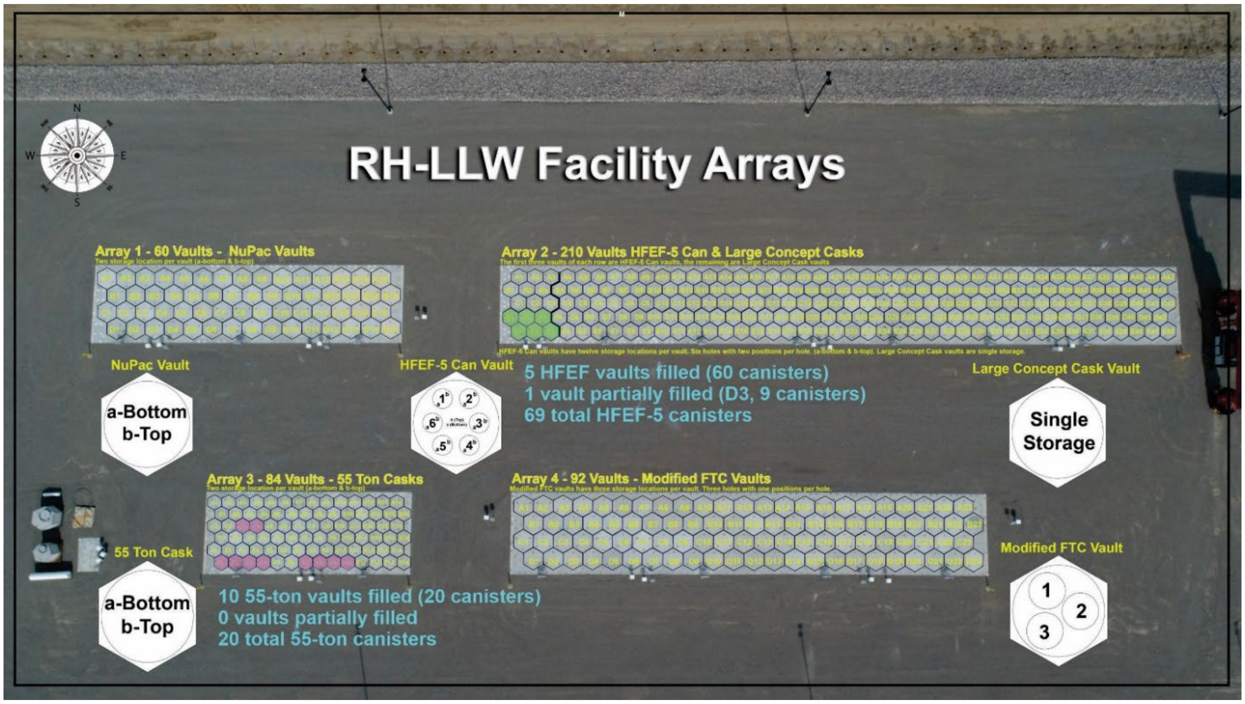

Figure 4. RHLLW canister-disposal locations through FY 2024.

4.3. Radionuclide Inventory Tracking Using RHINO

A running total of radionuclide activities disposed of by vault array, generator, and waste form is recorded and tracked using the facility inventory management system, RHINO (TFR-981 2018). Table 6 shows the breakdown of activity by waste form for each generator and canister type in FY 2024. The information shows 230 radionuclides were reported in AMs and 103 radionuclides as surface contamination, for a total activity of 16,311 Ci in all 19 waste canisters. The majority of activity (99.94%) was in the form of activated metal, and 87% of that was Ni-63.

Four of the reported radionuclides are non-system radionuclides, meaning they are not included in the RHINO database. Non-system radionuclides are evaluated using the UDQE process (see Section 2.1). The total activity of non-system radionuclides reported in FY 2024 was 6.5E-05 Ci. Radionuclide reporting requirements are documented in the WAC (PLN-5446).

Table 6. Radionuclides and activities disposed of by generator and waste form in FY 2024.

	NRF 15 55-ton canisters		ATR 3 ATR-5 canisters		MFC 1 HFEF-5 canister		All 19 canisters	
Waste form	Nuclides reported	Activity (Ci)	Nuclides reported	Activity (Ci)	Nuclides reported	Activity (Ci)	Nuclides reported	Activity (Ci)
Activated metal	221	15,534	86	766	16	2.6	230	16,303
Surface Contamination	97	8.6	9	3E-5	29	0.18	103	8.7
Total	224[a]	15,542	90[a]	766	41[a]	2.8	235[a]	16,311

a. Activated metal and surface contamination radionuclide numbers may not add up to the total because some radionuclides were reported as both activated metal and surface contamination.

As part of the canister-acceptance process, dose calculations are performed by RHINO based on the reported activities of the 14 radionuclides fully analyzed in the PA for the groundwater pathway, the 5 radionuclides that account for 99% of the chronic-intruder dose (limiting intruder scenario) in the PA, and the 3 radionuclides considered in the final air-pathway screening in the PA. The air pathway was screened out in the PA, but the three radionuclides, which are considered in the final air-pathway screening step are included in the 14 groundwater pathway radionuclides and potential doses via the air pathway, are calculated by RHINO. Table 7 contains the inventory emplaced in FY 2024 and cumulative inventory for the 14 groundwater pathway radionuclides fully analyzed in the PA. These are recorded and presented by array, generator, and waste form. Table 8 shows similar information for the radionuclide inventories that contribute to the intruder dose.

At the end of FY 2024, the NRF 55-ton vault array was nearly 12% full based on canister capacity (see Table 4). The 14 groundwater pathway radionuclide inventories for this generator, canister, and waste forms as a percentage of the PA base-case inventory (see Table 7, last column) are within 20% of this number, with some exceptions. The percentages in activated metal (A) of Tc-99 (47%), Cl-36 (57%), and Mo-93 (61%) are 4–5 times greater than 12%. The percentages of some radionuclides as surface contamination (S) are also significantly greater than 12%. These include Pu-239 (50%), Pu-240 (102%), U-234 (1,313%), and Np-237 (23,026%).

At the end of FY 2024, the HFEF-5 vault array was 38% full based on canister capacity (see Table 4). Although three ATR-5 canisters have been emplaced in this array, most of the canisters (66) are HFEF-5 canisters from MFC. The radionuclide inventories for MFC HFEF-5 canisters and waste forms as a percentage of the PA base-case inventory (see Table 7, last column) are less than or reasonably close to 38%, with some exceptions. U-234, U-235, and U-238 as surface contamination are roughly 200% of the PA base-case inventory. Pu-240 and Np-237 are 1,042% and 2,637% of the PA base-case inventories.

All occurrences of canisters with higher-than-expected inventories are flagged by RHINO and evaluated through the UDQE process. Although the emplaced inventories of some radionuclides are greater than the projected PA base-case inventories, they are typically small compared to the PA base-case inventories for all generators and canisters, or the PA base-case inventories were relatively small. This explains why the projected all-pathway dose contributed by these radionuclides is not significant with respect to performance objectives (see Section 4.4).

Table 7. Key groundwater pathway radionuclide activities disposed of by array, generator, and waste form through FY 2024 compared to base case inventory analyzed in the PA.

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2024 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
C-14	55-Ton	NRF	A	1.02E+00	1.73E+00	4.78E+01	3.62%
			R	—	—	2.36E-02	—
			S	9.49E-02	1.43E-01	8.09E-01	17.7%
	HFEF-5	ATR	A	1.51E-01	1.51E-01	2.36E+01	0.64%
		MFC	A		5.97E-01	2.75E+00	21.7%
			S	2.45E-07	2.45E-07	—	N/A
	NFC	NRF	A	—	—	1.12E+02	—
			R	—	—	5.40E-02	—
			S	—	—	6.98E+00	—
	Modified FTC	MFC	A	—	—	1.95E+01	—
			S	—	—	2.87E-01	—
	NuPAC	ATR	R	—	—	9.77E-01	—
Cl-36	55-Ton	NRF	A	2.22E-04	1.26E-02	2.21E-02	57.2%

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2024 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
	HFEF-5	ATR	A	6.46E-09	6.46E-09	3.40E-06	0.19%
	NFC	NRF	A	—	—	9.24E-02	—
H-3	55-Ton	NRF	A	7.42E-01	1.21E+00	6.12E+01	1.97%
			R	—	—	1.14E+00	—
			S	1.54E-04	1.62E-04	—	N/A
	HFEF-5	ATR	A	1.42E+00	1.42E+00	1.76E+03	0.08%
		MFC	A	1.35E-04	3.33E-01	1.21E+01	2.75%
			S	—	2.88E-05	3.49E-05	82.6%
	NFC	NRF	A	—	—	1.47E+02	—
			R	—	—	2.61E+00	—
	NuPAC	ATR	R	—	—	1.09E-01	—
I-129	55-Ton	NRF	A	4.69E-08	8.60E-08	2.14E-06	4.02%
			R	—	—	5.52E-07	—
			S	4.05E-07	5.96E-07	2.66E-06	22.4%
	HFEF-5	ATR	A	1.98E-18	1.98E-18	2.47E-15	0.08%
		MFC	S	—	4.00E-08	4.40E-09	908%
	NFC	NRF	A	—	—	5.87E-06	—
			R	—	—	1.27E-06	—
			S	—	—	1.94E-05	—
	Modified FTC	MFC	S	—	—	4.83E-04	—
	NuPAC	ATR	R	—	—	5.33E-02	—
Mo-93	55-Ton	NRF	A	9.93E-02	1.30E-01	2.11E-01	61.3%
	HFEF-5	ATR	A	3.18E-03	3.18E-03	5.41E-01	0.59%
		MFC	A	5.73E-02	1.35E+00	2.78E+00	48.5%
	NFC	NRF	A	—	—	2.61E-01	—
	Modified FTC	MFC	A	—	—	2.17E+01	—
			S	—	—	3.19E-01	—
Nb-94	55-Ton	NRF	A	4.24E-01	5.96E-01	3.71E+00	16.1%
			R	—	—	6.16E-10	—
			S	2.15E-03	3.11E-03	1.15E-02	27.0%
	HFEF-5	ATR	A	2.14E-01	2.14E-01	3.82E+01	0.56%
		MFC	A	1.63E-05	7.06E-01	1.11E+00	63.7%
	NFC	NRF	A	—	—	8.31E+00	—
			R	—	—	1.41E-09	—
			S	—	—	1.46E-01	—
	Modified FTC	MFC	A	—	—	4.74E+00	—
			S	—	—	7.02E-02	—
	NuPAC	ATR	R	—	—	8.48E-01	—
Ni-59	55-Ton	NRF	A	1.34E+02	1.50E+02	5.83E+02	25.7%

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2024 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
			R	—	—	3.39E+00	—
			S	2.92E-02	4.36E-02	3.16E-01	13.8%
	HFEF-5	ATR	A	1.09E+00	1.09E+00	1.90E+02	0.57%
		MFC	A	5.24E-02	2.56E+00	8.85E+00	28.9%
	NFC	NRF	A	—	—	9.30E+02	—
			R	—	—	7.76E+00	—
			S	—	—	3.19E+00	—
	Modified FTC	MFC	A	—	—	9.05E+01	—
			S	—	—	1.33E+00	—
	NuPAC	ATR	R	—	—	7.61E-01	—
Np-237	55-Ton	NRF	A	3.47E-08	2.30E-07	1.76E-06	13.0%
			R	—	—	4.49E-06	—
			S	7.72E-07	7.72E-07	3.35E-09	23026%
	HFEF-5	MFC	S	7.35E-09	1.81E-06	6.86E-08	2637%
	NFC	NRF	A	—	—	4.49E-06	—
			R	—	—	1.03E-05	—
			S	—	—	6.89E-08	—
	Modified FTC	MFC	S	—	—	5.82E-04	—
	NuPAC	ATR	R	—	—	9.18E-05	—
Pu-239	55-Ton	NRF	A	8.31E-04	3.22E-03	6.60E-02	4.87%
			R	—	—	3.09E-05	—
			S	3.35E-05	3.55E-05	7.04E-05	50.4%
	HFEF-5	MFC	S	3.10E-05	1.46E-02	1.56E-02	93.1%
	NFC	NRF	A	—	—	1.47E-01	—
			R	—	—	7.07E-05	—
			S	—	—	3.78E-04	—
	Modified FTC	MFC	S	—	—	2.99E-01	—
	NuPAC	ATR	R	—	—	2.88E-02	—
Pu-240	55-Ton	NRF	A	7.61E-04	1.30E-03	5.67E-02	2.29%
			R	—	—	6.31E-05	—
			S	6.19E-05	6.31E-05	6.22E-05	102%
	HFEF-5	MFC	S	3.06E-06	6.36E-04	6.11E-05	1042%
	NFC	NRF	A	—	—	1.15E-01	—
			R	—	—	1.45E-04	—
			S	—	—	3.13E-04	—
	Modified FTC	MFC	S	—	—	1.85E-03	—
	NuPAC	ATR	R	—	—	1.81E-03	—
Tc-99	55-Ton	NRF	A	1.33E-02	1.67E-02	3.54E-02	47.2%
			R	—	—	1.69E-02	—

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2024 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
			S	3.41E-04	4.59E-04	1.43E-03	32.1%
	HFEF-5	ATR	A	1.50E-04	1.50E-04	2.58E-02	0.58%
		MFC	A	2.57E-03	1.83E-02	—	N/A
			S	2.39E-07	1.66E-01	5.36E-01	30.9%
	NFC	NRF	A	—	—	3.73E-02	—
			R	—	—	3.87E-02	—
			S	—	—	8.29E-03	—
	Modified FTC	MFC	S	—	—	2.57E+00	—
	NuPAC	ATR	R	—	—	1.97E+00	—
U-234	55-Ton	NRF	A	1.47E-06	3.11E-06	2.64E-05	11.8%
			R	—	—	8.28E-05	—
			S	6.26E-06	6.27E-06	4.78E-07	1313%
	HFEF-5	MFC	S	1.36E-06	2.28E-04	1.17E-04	194%
	NFC	NRF	A	—	—	9.36E-05	—
			R	—	—	1.90E-04	—
			S	—	—	1.59E-06	—
	Modified FTC	MFC	S	—	—	5.16E-06	—
	NuPAC	ATR	R	—	—	9.18E-05	—
U-235	55-Ton	NRF	A	5.82E-08	1.18E-07	4.49E-07	26.3%
			R	—	—	1.11E-06	—
			S	1.98E-12	2.99E-12	1.57E-10	1.90%
	HFEF-5	MFC	S	5.75E-08	3.01E-06	1.81E-06	166%
	NFC	NRF	A	—	—	2.53E-06	—
			R	—	—	2.54E-06	—
			S	—	—	2.18E-10	—
	Modified FTC	MFC	S	—	—	3.70E-03	—
	NuPAC	ATR	R	—	—	4.53E-06	—
U-238	55-Ton	NRF	A	1.39E-06	2.95E-06	3.10E-05	9.54%
			R	—	—	5.13E-09	—
			S	4.62E-10	6.97E-10	1.40E-08	4.99%
	HFEF-5	MFC	S	1.90E-08	2.03E-06	9.11E-07	223%
	NFC	NRF	A	—	—	1.04E-04	—
			R	—	—	1.18E-08	—
			S	—	—	2.92E-08	—
	Modified FTC	MFC	S	—	—	7.40E-04	—

a. Waste forms include A = activated metals, R = resin, S = surface contamination. Surface contamination may be on debris or activated metal components.

b. Cumulative inventory from Table 3-2 in the PA (DOE-ID 2018a). For this table, the cumulative inventory for MFC waste in the HFEF-5 vault array is the combined HFEF-Legacy and HFEF-Future (new-generation) wastes from Table 3-2 of the PA (or Tables 8 and 9 of ECAR-3940, "Baseline Radionuclide Inventory for The Remote-Handled Low-Level Waste

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2024 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory

Disposal Facility for Use in the Facility Performance Assessment"). They are combined because both are treated the same for calculating the all-pathway PA dose.

c. Tritium (H-3) as surface contamination was not reported in the proposed inventory for NRF 55-ton canisters evaluated for the PA. However, because tritium as surface contamination is listed in other waste streams, the dose is calculated by RHINO and included in the all-pathway dose contribution.

d. Tc-99 as activated metal was not reported in the proposed inventory for MFC-legacy or new-generation HFEF-5 canisters evaluated for the PA. However, because Tc-99 is listed in the ATR waste stream also destined for the HFEF-vault array, the dose is calculated by RHINO and included in the all-pathway dose contribution.

Table 8 presents the FY 2024 and cumulative inventory for the five radionuclides that are the primary contributors to the chronic-intruder-pathway dose. These radionuclides and activities are only presented by vault array because the canister type and waste form are not important for calculating intruder dose.

The inventory shows Cs-137 and Sr-90 are the highest percent of the HFEF-5 vault-array action level at 15.4% and 14.8%, respectively. Given the total number of HFEF-5 canisters emplaced through FY 2024 is 38.3% of the HFEF-vault array capacity (Table 4), the cumulative inventories of these two radionuclides are presently not a cause for concern; however, the percentages will continue to be monitored. Cumulative inventories in the 55-ton vault array are a small fraction of the vault-array action levels.

Table 8. Radionuclide inventory of primary dose contributors to the chronic-intruder pathway through FY 2024.

Nuclide	Vault Array	FY 2024 Inventory (Ci)	Cumulative Inventory Through FY 2024 (Ci)	Vault Array Action Level[a] (Ci)	Cumulative Inventory Through FY 2024 as % of Vault Array Action Level
Co-60	55-ton	9.51E+02	1.04E+03	7.33E+05	0.14%
	HFEF-5	4.34E+02	8.91E+03	3.79E+06	0.24%
	NFC	—	—	1.17E+06	—
	Modified FTC	—	—	2.68E+04	—
	NuPac	—	—	4.24E+03	—
Cs-137	55-ton	8.52E-02	1.11E-01	1.27E+02	0.09%
	HFEF-5	8.57E-02	9.40E+00	6.12E+01	15.4%
	NFC	—	—	2.76E+02	—
	Modified FTC	—	—	1.69E+04	—
	NuPac	—	—	1.14E+02	—
Nb-94	55-ton	4.26E-01	6.00E-01	6.88E+01	0.87%
	HFEF-5	2.14E-01	9.20E-01	7.27E+02	0.13%
	NFC	—	—	1.57E+02	—
	Modified FTC	—	—	8.90E+01	—
	NuPac	—	—	1.57E+01	—
Ni-63	55-ton	1.41E+04	1.56E+04	1.36E+06	1.15%
	HFEF-5	1.42E+02	8.79E+03	4.68E+05	1.88%
	NFC	—	—	2.11E+06	—
	Modified FTC	—	—	8.64E+04	—

	NuPac	—	—	6.29E+02	—
Sr-90	55-ton	8.55E-02	1.01E-01	8.53E+01	0.12%
	HFEF-5	4.63E-03	1.85E+01	1.25E+02	14.8%
	NFC	—	—	1.92E+02	—
	Modified FTC	—	—	1.17E+04	—
	NuPac	—	—	3.00E+02	—

a. Vault-array action levels (ECAR-2073 2018, Table A-3, or INL 2018, Table 20) are based on the ratio of the chronic dose standard (100 mrem/year) to the total estimated chronic-intruder dose in the PA (5.42 mrem/year). This ratio, 100/5.42 = 18.5, was multiplied by the estimated PA base-case inventory of each radionuclide in each vault array to calculate action levels. They are not disposal limits, but exceedance of an action level for one vault array would trigger a review of disposals in all vault arrays.

4.4. Performance Objectives Tracking Using RHINO

The RHLLW Disposal Facility does not depend on the radionuclide sum-of-fractions rule[10] to determine compliance with performance objectives. Rather, the facility uses the RHINO software to calculate facility performance with each shipment and disposal. In addition to tracking inventory and performing canister-acceptance checks based on the WAC, RHINO calculates the maximum all-pathways dose, air-pathway dose, chronic-intruder dose, and applicable groundwater concentrations as each canister is considered for shipment. RHINO can also calculate these performance measures for annual and cumulative disposals. The calculated values are compared to canister and facility-wide threshold values and regulatory-performance objectives to determine waste acceptance. The calculations are performed using abstractions of the PA model, so the results are as if the PA model were used. The calculations are performed only for the radionuclides not screened out in the PA and account for the majority of the dose. The technical basis, methodology, and implementation used in RHINO is described in INL/EXT-18-45184, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC" (INL 2018).

The reason the sum-of-fractions rule is not used to determine compliance is that, except for the intruder dose, the PA calculates dose and concentration performance measures based on vault array (location), canister type, and waste form for each radionuclide. For example, a curie of tritium in activated metal in a 55-ton waste canister in the 55-ton vault array does not have the same impact on the groundwater or air-pathway dose as a curie of tritium on SC debris in an HFEF-5 canister in the HFEF-vault array.

Table 9 summarizes the performance measures for all disposals in FY 2024 and cumulative disposals through FY 2024. As expected, the calculated-dose and concentration-performance measures for all canisters emplaced through FY 2024 are a small fraction of the applicable performance objectives. Based on this, the impact of cumulative disposals is not inconsistent with PA predictions, and there are no impacts to the assumptions or conclusions of the PA.

10 The sum-of-fraction rule for mixtures of radionuclides in waste is often used to determine the amount of each radionuclide that can be disposed of based on its limit derived from the PA. It is calculated by dividing each nuclide's concentration or dose contribution by the appropriate limit and adding each of the resulting values. If the sum is less than 1.0, then the limit has not been exceeded.

Table 9. Summary of facility performance through FY 2024.

Performance Objective or Measure	Performance Standard	Point of Assessment Location	Compliance Period			Post-Compliance Period		
			Maximum Based on FY 2024 Disposals	Maximum Based on Cumulative Disposals Through FY 2024	Cumulative Disposal Maximum as % of Standard	Maximum Based on FY 2024 Disposals	Maximum Based on Cumulative Disposals Through FY 2024	Cumulative Disposal Maximum as % of Standard
All-Pathway Dose	25 mrem/yr	100 m	5.53E-10	1.35E-04	0.0005%	1.01E-03	7.88E-02	0.32%
Air-Pathway Dose[a]	10 mrem/yr	100 m	1.12E-04[b]	1.70E-04[b]	0.002%[b]	N/A[c]	N/A[c]	N/A[c]
Intruder Dose	100 mrem/yr	Facility	1.18E-01	2.54E-01	0.25%	N/A[c]	N/A[c]	N/A[c]
Beta-Gamma DE[d]	4 mrem/yr	100 m	3.93E-10[e]	9.62E-05[e]	0.002%[e]	2.02E-03[e]	5.60E-02[e]	1.40%[e]
Beta-Gamma ED[d]	4 mrem/yr	100 m	2.15E-10[e]	5.26E-05[e]	0.0013%[e]	2.91E-04[e]	3.06E-02[e]	0.77%[e]
Gross Alpha	15 pCi/L	100 m	2.93E-32	4.55E-30	3.03E-29%	1.75E-06	6.37E-06	0.00004%
Ra-226/228	5 pCi/L	100 m	1.31E-34	2.19E-32	4.38E-31%	8.95E-08	2.04E-06	0.00004%
Uranium Mass	30 ug/L	100 m	9.90E-30	8.88E-28	2.93E-27%	3.36E-07	1.69E-05	0.00006%

a. Although the air pathway was screened out in the PA, air-pathway doses are calculated by RHINO using the Phase III air-pathway screening model from the PA. RHINO does not calculate radon flux because the radon flux calculated in the PA was insignificant compared to the performance objective.

b. The air-pathway dose in the PA is due to C-14, H-3, and I-129.

c. Air-pathway and intruder doses peak during the compliance period. No doses are reported for the post-compliance period.

d. DE = dose equivalent, ED = effective dose.

e. Radionuclides that contribute to the beta-gamma DE and ED include C-14, Cl-36, H-3, I-129, Mo-93, Nb-94, Ni-59, and Tc-99 (DOE-ID 2018a, Sections 4.2.2 and 4.2.3).

5. MONITORING

Compliance and performance monitoring began in FY 2019 with the commencement of facility operations and is conducted in accordance with the monitoring plan, PLN-5501. PLN-5501 was developed to meet the requirements for monitoring the RHLLW Disposal Facility, according to the U.S. DOE Order 435.1, "Radioactive Waste Management," and the guidance provided in the associated technical standard, "Disposal Authorization Statement and Tank Closure Documentation" (DOE-STD-5002-2017).

The most important monitoring activities are associated with the groundwater exposure pathway. Water samples are collected from aquifer-monitoring wells and are analyzed to determine compliance with groundwater quality standards for radionuclides. Soil-porewater samples, collected from lysimeters in the vadose zone adjacent to and below the base of the vault arrays, are analyzed to evaluate facility performance.

The monitoring plan identifies two phases of monitoring: the baseline monitoring phase and the post-baseline monitoring phase. The baseline monitoring phase began in 2019 and ended in 2023. Aquifer and lysimeter monitoring data collected during the first four years of the baseline monitoring phase are summarized in INL 2023b. That summary provides statistical measures and a baseline condition for the facility that is used to evaluate future monitoring results and to demonstrate whether the facility is performing as established in the facility PA. The data can also be used to distinguish contaminant releases from the RHLLW Disposal Facility from pre-existing contamination and potential future releases from other sources (e.g., upgradient aquifer sources). FY 2024 is the first year of the post-baseline monitoring phase. Aquifer and lysimeter-sample results from FY 2024 are summarized and discussed in Sections 5.1 and 5.2, respectively.

No air- or radon-emissions monitoring is performed for the facility because the air and radon pathways were screened from a detailed analysis in the PA. However, the INL Site ambient-air-monitoring program operates a network of low-volume air samplers to monitor the INL Site and surrounding region for atmospheric levels of radioactive particulates, radioiodine, and tritium released from INL facilities, natural radioactivity, and fallout from worldwide nuclear detonations or accidents. One of the particulate samplers is located immediately outside the facility fence south of the vault yard. Results are presented in annual site environmental reports for each calendar year and reviewed for this ASR. The most recent results, published in Calendar Year 2023 (DOE-ID 2024), indicate gross alpha and gross beta were detected in concentrations consistent with historical measurements at the sampler near the RHLLW Disposal Facility. Composited quarterly samples were analyzed for specific radionuclides, and results were again consistent with historical measurements. All results were well below derived concentration standards established by DOE for inhaled air (DOE-STD-1196-2022).

The biotic-intrusion pathway was also screened from a detailed analysis in the PA, but the vault yard and side slopes are inspected annually for biotic activity (e.g., burrowing insects, animals, and plants) as part of the annual inspection under MWO 260064 (2018), covered under WO 362249 (2024) for Calendar Year 2024. Some vegetation growth on a few areas of the vault-yard perimeter were found during the inspection, and the vegetation was sprayed and/or removed.

Other monitoring activities performed at the facility include annual visual inspections of the vault-yard road apron, compaction measurements, and inspection of VSPs for damage. The road-apron inspection showed typical rutting, settling, erosion, sedimentation, and uneven surfaces consistent with past annual inspections. All findings were deemed not significant in nature and expected for gravel surfaces, especially in industrial areas where heavy equipment is being operated (see Section 2.9.3.1). The scope of the vault inspection requires all VSP top surfaces of vaults that contain waste to be inspected, as well as the top surfaces of empty adjacent vaults. The inspection found four VSPs with cracks or chips/spalls that required repair. Damage and repairs (if necessary) are managed using the change control process (RH-ADM-5214). Repairs are scheduled for November 2024 (see Section 2.9.3.1).

In addition to annual inspections, a topographic survey of the vault yard is performed every three years and is scheduled for November 2024. It is expected that the survey will show there are no significant issues and only typically expected changes from initial configuration/conditions.

UDQEs associated with vault damage or repairs are presented in Section 2.1. Two vaults (see Figure 3 PA confirmation vaults) are not designed to receive waste, but are available for monitoring and study, as necessary. Currently, no plans to monitor or study the condition of these vaults (including the concrete and reinforcement) are in place, but monitoring may be initiated if trend data from lysimeter or aquifer samples are unfavorable, according to PLN-5501.

5.1. Compliance Monitoring

Compliance monitoring for the groundwater pathway is performed by sampling three aquifer wells near the RHLLW Disposal Facility (see Figure 5). Two wells, USGS-140 and USGS-141, are located approximately 100 m downgradient of the vault-yard fence, and one aquifer well, USGS-136, is located approximately 20 m upgradient of the vault yard. Samples are collected annually from each well and analyzed for target and indicator analytes to confirm compliance with state groundwater quality standards (IDAPA 58.01.11). If performance-monitoring concentrations (Section 5.2) exceed action levels, compliance monitoring frequency is increased from annual to semiannual.

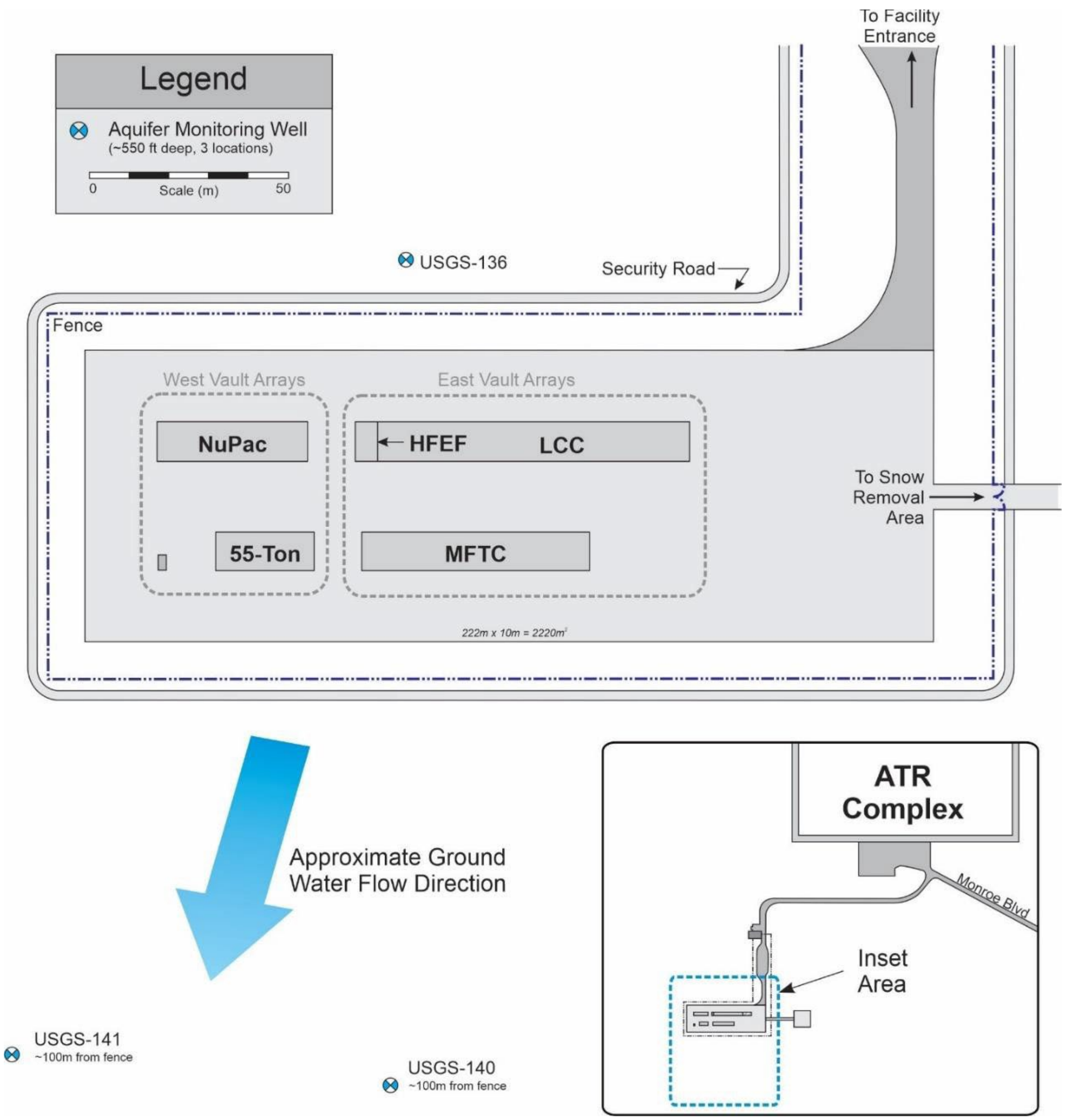

Figure 5. RHLLW Disposal Facility layout showing aquifer-monitoring well locations.

Table 3 of PLN-5501 lists 14 key radionuclides as contaminants of potential concern for the groundwater pathway. These are the 14 radionuclides that failed the groundwater pathway screening and were fully analyzed in the PA. For monitoring, four key radionuclides (H-3, C-14, Tc-99, and I-129) were selected as target analytes due to their greater mobility and predicted impact on the all-pathways dose. In addition to target analytes, samples are analyzed for indicator analytes, gross alpha, and gross beta. The PA demonstrated that there are no principal contaminants of concern that undergo gamma decay that would be expected to affect the groundwater pathway; therefore, gamma monitoring is not included in the compliance monitoring.

Samples were collected from each of the three aquifer wells in April 2024. Results of the compliance monitoring are presented in Appendix B, "Compliance and Performance-Monitoring Data for the RHLLW Disposal Facility," and summarized in Table 10. Tritium from upgradient sources was detected in all three aquifer wells, and concentrations continue to exhibit a decreasing trend consistent with regional trends observed in DOE-ID (2021). Gross beta was positively detected in all three wells in FY 2024 while gross alpha was detected in two of the wells (USGS-136 and USGS-141). Historically, gross alpha and gross beta have been detected in all three wells at low levels (<5 pCi/L), with gross alpha being detected less frequently than gross beta. In FY 2024, C-14, I-129, and Tc-99 were not detected in any samples from the three wells, which has been the case since 2019. All results are consistent with concentrations in the aquifer established prior to facility completion (INL 2017).

5.2. Performance Monitoring

Performance monitoring of the facility is achieved by analysis of soil-porewater samples collected from vadose-zone lysimeters. Prior to operations, lysimeters were installed adjacent to vault arrays (see Figure 6) in native materials at three general depths: (1) shallow alluvium, below the drainage course material at the base of the vaults (~26–29 ft bls), (2) deep alluvium, above the upper basalt contact (~40–44 ft bls), and (3) sedimentary interbeds (~171–176 ft bls).

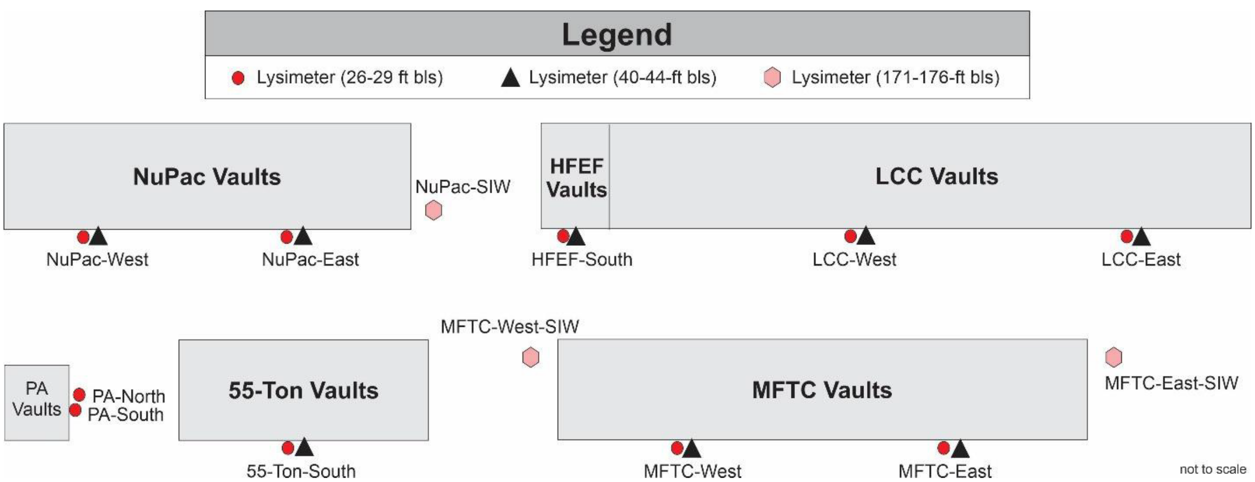

Figure 6. Plan view of the vault arrays showing the lysimeter locations.

During the baseline monitoring phase, attempts were made to collect samples from all lysimeters. The monitoring plan was revised in FY 2024 based on lessons learned during the baseline monitoring phase. The changes impact the post-baseline monitoring phase and include the following:

- Increasing the gross-alpha action level for performance monitoring from 10–20 pCi/L.
- Adding tritium to the analyte list. Previously, it included only gross alpha and gross beta.
- Sampling only lysimeters that produce enough water for analysis from one or two sample events and only sample one shallow alluvium lysimeter from each vault array. This reduced the number of lysimeters to be sampled to five shallow alluvium lysimeters and one sedimentary-interbed lysimeter.

In addition, changes were made to response actions when action levels are exceeded. During the post-baseline monitoring phase, lysimeter samples will now be collected annually (in the spring) as long as positive detections of either gross alpha or gross beta do not exceed action levels at any of the monitoring locations. If a gross-alpha or gross-beta action level is exceeded, sampling frequency is increased to semiannual for lysimeters where an action level was exceeded. The first semiannual sample will be analyzed for gross alpha, gross beta, and tritium. If a gross alpha or gross beta result from the first semiannual sample also exceeds an action level (i.e., two consecutive exceedances of either gross alpha or gross beta), all future semiannual samples from that lysimeter will be speciated (alpha or beta depending on the action level exceeded) to determine the actual contributing radionuclides. Semiannual sampling and speciation for the lysimeter with the exceedance(s) will continue until the gross alpha, gross beta, and/or tritium results are less than the respective action level for two consecutive samples. Because gross alpha, gross beta, and tritium are destructive analyses, speciation will require additional sample volume. Thus, the lysimeters may need to be resampled multiple times until enough sample is collected for the desired analyses or until water is no longer available.

In FY 2024, samples were collected from all six lysimeters specified in the monitoring plan for the post-baseline monitoring phase. This includes five shallow alluvium lysimeters (one from each vault array) and one sedimentary-interbed lysimeter. Five of the lysimeters produced 500 mL or more from a single sample event. That volume was sufficient for analysis of all analytes (gross alpha, gross beta, and tritium) with some extra for duplicate analysis of some analytes. HFEF-South was sampled on three occasions and produced 318 mL, which was only enough for the original analyses without duplicates. Results are presented in Appendix B, "Compliance and Performance-Monitoring Data for the RHLLW Disposal Facility," and summarized in Table 11. Gross alpha and gross beta were positively identified in all six lysimeters in either the original sample or the duplicate. The results were all less than action levels and within the bounds identified in the baseline data summary report (INL 2023b).

Tritium was positively identified in only one lysimeter (HFEF-South), which is consistent with the previous year. Lysimeter HFEF-South had an unexpectedly high tritium result in FY 2020 (47,100 pCi/L), which is discussed in detail in Section 5.2.1 of the FY 2021 ASR (INL 2022a). Although there was no action level for tritium in soil porewater, a decision was made after the unexpectedly high tritium concentration to conduct semiannual sampling of selected lysimeters until the tritium concentration in lysimeter HFEF-South declined to less than the federal drinking water maximum-contaminant level (MCL) of 20,000 pCi/L. Tritium levels in HFEF-South have declined since 2020, and concentrations have been below 20,000 pCi/L since October 2022 (see Figure 7). The Spring 2024 result of 4,100 pCi/L is similar to the past two sample results. Although the tritium concentration has leveled off during the past year, concentrations are expected to continue to decline. Nevertheless, the concentrations are not believed to be the result of waste being released from inside a waste canister, and are not a significant threat to the aquifer. When the monitoring plan was revised in 2023, the action level for tritium in lysimeter samples was set at 100,000 pCi/L.

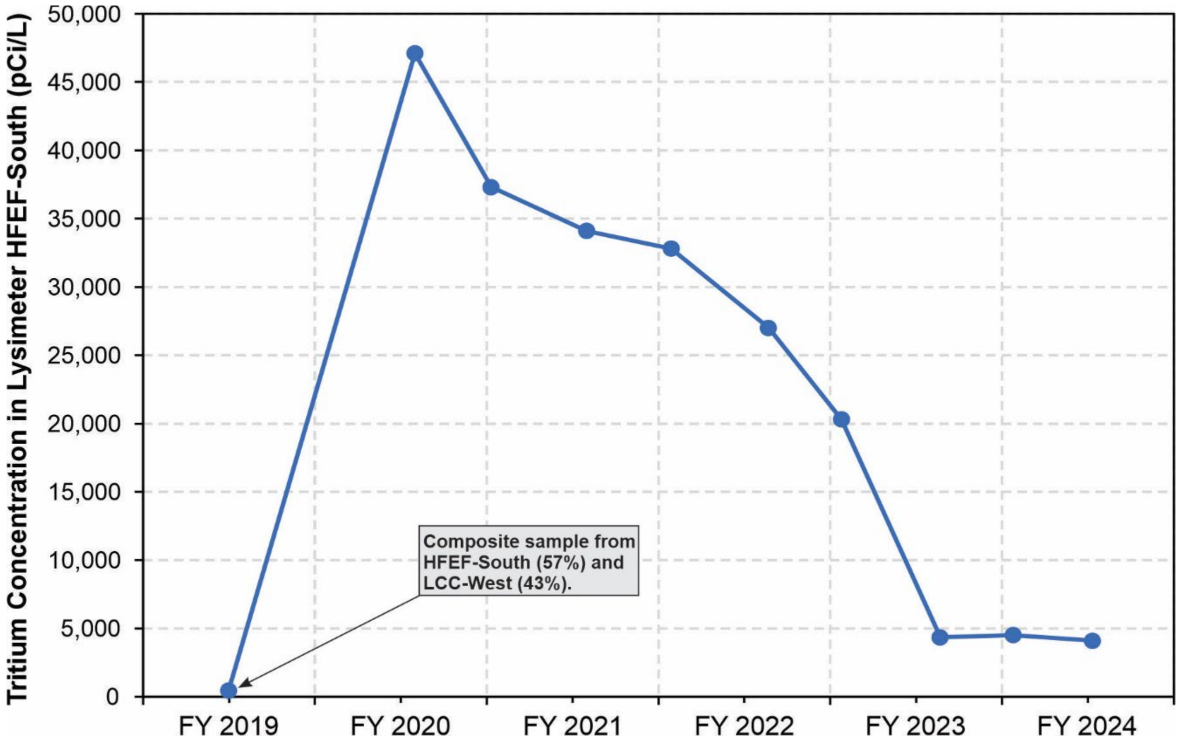

Figure 7. Tritium concentration time history in lysimeter HFEF-South.

Table 10. Compliance monitoring summary for the RHLLW Disposal Facility in FY 2024.

Monitoring Location	Monitoring Type	Monitoring Results	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA/CA Impacts
RHLLW Disposal Facility Vicinity (Aquifer wells USGS-136, USGS-140, and USGS-141)	Groundwater (indicator analytes gross alpha, gross beta, and target analytes C-14, H-3, I-129, and Tc-99)	Tritium (H-3) was detected in all three aquifer wells and continues to show a decreasing trend. Gross beta was positively detected in all three wells. Gross alpha was detected in wells USGS-136 and USGS-141. C-14, I-129 and Tc-99 were not detected in any samples. Results are all significantly less than regulatory limits and consistent with historical measurements (INL 2017).	State of Idaho Groundwater Quality Rule (IDAPA 58.01.11)	Drinking water MCLs and Idaho State groundwater protection standards.	No actions taken. Routine sampling is scheduled annually and will continue as long as performance-monitoring action levels are not exceeded.	None. No impacts to PA/CA results and conclusions.
CA = composite analysis IDAPA = Idaho Administrative Procedures Act PA = performance assessment						

Table 11. Performance-monitoring summary for the RHLLW Disposal Facility in FY 2024.

Monitoring Location	Monitoring Purpose	Monitoring Results and Trends	PA Expected Behavior	Action Taken	PA/CA Impacts
Six vadose-zone lysimeters adjacent to and below the disposal vaults (NuPac-West, 55-ton-South, HFEF-South, LCC-East, MFTC-West, and MFTC-East-SIW).	Provide data to indicate potential radionuclide release from source zone and migration toward aquifer.	Five of the six lysimeters sampled produced sufficient water for the full suite of analytes and some duplicates after one sample event. One lysimeter required three sample events to get enough water for analysis of all three analytes. Gross alpha and gross beta were positively identified in all six lysimeters in either the original sample or the duplicate. Tritium concentrations in lysimeter HFEF-South continued to decline but only slightly from the previous result. All results were all less than action levels and within the bounds identified in the baseline data summary report (INL 2023b).	FY 2024 is the first year of the post-baseline monitoring phase. Because very little waste has been emplaced and only in two locations (see Figure 4), the concentrations are considered not to have been impacted by disposals. Therefore, concentrations are considered reflective of background concentrations with the exception of the elevated tritium result from the HFEF-South lysimeter. The impact of the elevated tritium on the PA predicted groundwater dose is insignificant (see Section 5.2.1 of the FY 2021 ASR, INL 2022a), and monitoring results are consistent with assumptions and results from the PA.	No actions taken. Routine sampling is scheduled annually and will continue as long as performance-monitoring action levels are not exceeded.	None. No impacts to PA/CA results and conclusions.
CA = composite analysis PA = performance assessment					

6. RESEARCH AND DEVELOPMENT

No research and development activities were conducted at the RHLLW Disposal Facility in FY 2024 (see Table 12).

Table 12. Research and development activities.

Document Number	Results	PA/CA Impacts
None	N/A	N/A

7. PLANNED OR CONTEMPLATED CHANGES

Planned or contemplated changes in FY 2025 are presented in Table 13. The only planned change to a technical-basis document is an update to the WAC (PLN-5446). A WAC update was planned for FY 2024, but was postponed so that other similar changes identified during FY 2024 could be incorporated into a single revision. Thus, the update is scheduled to be complete in FY 2025. Changes to the WAC include updates to radionuclide tables in Appendix B. The tables will be updated to include radionuclides that could be reported in approved waste streams that were not included in the projected PA base case inventory.[11] They include the addition of the following:

- Eight radionuclides that may be reported as surface contamination on NRF debris. These radionuclides were reported by NRF Waste Programs in TWR-21794 (2021) and evaluated in UDQE-RHLLW-052. Tables B-6 and B-8 in the WAC will be updated to include Eu-152, Eu-154, Eu-155, H-3, Hf-175, Ru-103, Sn-113, and Ta-182. Although radionuclides on AMs were evaluated during preparation of the PA, radionuclides on debris were not considered. The debris includes nylon lanyards, steel water pool hooks, and nylon rigging straps.
- Eleven radionuclides that may be reported as contamination on NRF resins. These were reported by NRF in Nelson (2023) and evaluated in UDQE-RHLLW-079. Table B-7 in the WAC will be updated to include Cf-249, Cf-251, Cm-245, Cm-246, Cm-247, Cm-248, Pu-244, Sn-126, Th-232, U-232, and Zn-65. The NRF base case resin inventory was reassessed based on plans to extend the life (time in pool) of resin modules. New radionuclides were identified based on the use of a more recent (2022) water pool radionuclide distribution.
- Nine radionuclides that may be reported as surface contamination on AMs from the ATR Complex. These were reported by ATR Waste Programs in ECAR-5772 and evaluated in UDQE-RHLLW-088. Table B-1 in the WAC will be updated to include Co-58, Co-60, Cr-51, Hf-175, Hf-181, Mo-99, Na-24, Re-188, and Sb-124. Radionuclides as surface contamination on AMs from the ATR Complex were not evaluated during preparation of the PA.

The only key radionuclide being added to the WAC tables is tritium (H-3) on NRF-activated metal and debris. Because tritium as surface contamination was not included in the PA for this waste stream, it was necessary to verify it is included in RHINO dose calculations. This was verified and Table 3 of INL/EXT-18-45184, *Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC,* (INL 2018) will be updated to indicate there is a response function for tritium as surface contamination on NRF-AMs and debris.

[11] Footnotes will be added to the tables in the WAC to identify these radionuclides as being evaluated through the change control process and not part of the original PA.

One other change identified in Table 13 is a potential change. The change will be based on an evaluation of an updated estimate of radionuclide activities in legacy and new-generation HFEF-5 waste canisters from MFC (ECAR-5959). The updated activity estimate was initiated in response to discrepancies between projected PA base case inventories and updated canister inventories determined from dose-rate measurements taken prior to shipping the canister to the RHLLW Disposal Facility. An evaluation of the updated activity estimates began in FY 2024 and is expected to be complete in FY 2025. The updated inventories have the potential to impact the PA and will be evaluated using the change control process.

The identified changes to the WAC are not expected to impact the PA, CA, ODAS, or the RHLLW Disposal Facility design, operations, closure, research and development, or land use. The impact of the updated HFEF-5 inventory evaluation will be determined and evaluated using the change control process.

Table 13. Planned or contemplated changes for the RHLLW Disposal Facility.

Planned or Contemplated Change	Change Basis	PA/CA Impact	Schedule
Update WAC (PLN-5446)	Reassessments of waste streams from NRF and ATR Complex identified radionuclides that were not evaluated during preparation of the PA. As a result, tables in Appendix B of the WAC will be updated to include new radionuclides identified on (1) NRF SC debris, (2) NRF resins, and (3) ATR-AMs. Each change was evaluated using the change control process, and results are documented in UDQE-RHLLW-052, UDQE-RHLLW-079, and UDQE-RHLLW-088.	None	FY 2025
Evaluate potential impacts of updated radionuclide inventories for HFEF-5 waste canisters from MFC	Discrepancies between canister inventories used for the PA and updated canister inventories estimated prior to shipping prompted a reevaluation of the inventories used for the PA. The results of this evaluation documented in ECAR-5959 have the potential to impact the PA. The potential impacts are being evaluated using the change control process.	TBD	FY 2025

8. STATUS OF ODAS CONDITIONS AND KEY AND SECONDARY ISSUES

The PA, CA, and all related technical-basis documentation for the RHLLW Disposal Facility were reviewed and approved by the LFRG in FY 2018. The ODAS for the RHLLW Disposal Facility was approved in May 2018 (ODAS 2018). No conditions, key or secondary issues, or other findings were identified by the LFRG in FY 2024.

No outstanding issues or conditions were placed on disposal operations at the RHLLW Disposal Facility as a result of recent assessments, ODAS conditions, or key and secondary issues identified during LFRG review of the PA and CA (see Table 14).

Table 14. ODAS conditions and key and secondary issues.

Disposal Facility/Unit	Key/Secondary Issue or ODAS Condition Number	Issue Description	Initial Resolution Schedule Date	Projected Resolution Scheduled Date	Disposition Documentation and Date Completed	PA, CA, ODAS Impact
N/A[a]						

a. Not applicable for FY 2024.

9. DETERMINATION OF CONTINUED ADEQUACY OF THE PA, CA, ODAS, AND RWMB

The primary purpose of the RHLLW Disposal Facility ASR is to review the activities conducted over the past fiscal year to evaluate the adequacy of the assumptions and conclusions of the approved PA (DOE-ID 2018a), CA (DOE-ID 2012), CA Addendum (DOE-ID 2018b), ODAS (ODAS 2018), and RWMB (INL 2020a).

This FY 2024 ASR was reviewed and determined to demonstrate the continued adequacy of the PA, CA, ODAS, ODAS technical-basis documents, and the RWMB to meet the DOE Order 435.1 performance objectives for the RHLLW Disposal Facility. As presented in this report, it is determined that assumptions and conclusions of the PA, CA, and ODAS remain valid:

- No changes in operations or activities that might impact the PA and CA assumptions and conclusions have been identified (Section 2).
- Waste receipts were mostly consistent with the assumptions of the PA. Some differences in projected vs. actual waste receipts have been flagged by RHINO, but the impacts were determined to be within the bounds of the PA. All differences continue to be monitored and evaluated (Section 4).
- Compliance and performance-monitoring results indicate assumptions and conclusions of the PA and CA are appropriate (Section 5).
- Technical-basis documents revised in FY 2024 were the Monitoring Plan (PLN-5501) and the change control document (RH-ADM-5214) (see Section 2.9.2). All changes were evaluated using the change control process and were determined to be within the bounds of the PA. Projected disposal operations indicate continued compliance with the RWMB (Section 2). The most recent RWMB was approved by the field-element manager on December 11, 2020 (FY 2021). A draft of the next revision of the RWMB was completed in FY 2024 and is expected to be approved by DOE-ID in FY 2025.

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Appendix A

Fiscal Year 2024 Unreviewed Disposal Question Screenings and Evaluations for the RHLLW Disposal Facility

This appendix includes copies of unreviewed disposal question screenings (UDQSs) and unreviewed disposal question evaluations (UDQEs) that were completed and approved by the end of FY 2024. Evaluations that were initiated, but not completed, are listed as "in progress" in Table 2 of the ASR and are not included here. Evaluations that were cancelled are also not included here. The following are included herein:

- RHLLW-UDQE-099, Page 299
- RHLLW-UDQE-101, Page 312
- RHLLW-UDQE-102, Page 326
- RHLLW-UDQE-103, Page 337
- RHLLW-UDQE-105, Page 350

UDQE Tracking No.: UDQE-RHLLW-057

Subject: Evaluate Potential Impacts to RHLLW Disposal Facility Performance Assessment from Updated Standard DOE-STD-1196-2022

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Dose calculations for the RHLLW Disposal Facility performance assessment (PA) (DOE-ID 2018) were performed using dose coefficients from standard DOE-STD-1196-2011 (DOE 2011). A revised standard (DOE-STD-1196-2022, DOE 2022) provides updated derived concentration standards and per capita dose coefficients that reflect the current state of knowledge and practice in radiation protection, as well as updated demographic data for the U.S.

The purpose of this UDQE is to evaluate the impact of revised dose coefficients from the new standard on dose calculations performed for the RHLLW Disposal Facility PA. Although the standard notes that some dose coefficients have moderately significant changes as a result of improved dosimetry and an updated population distribution, the changes do not require revision of past calculations. Even though a revision of the current PA is not required for compliance with DOE requirements, it is recommended the impact of new dose coefficients in the revised standard be evaluated for planning purposes should the current PA need revision.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Dose coefficients from DOE-STD-1196-2011 were used as inputs to the existing RHLLW Disposal Facility PA. The current DOE Order 458.1 Chg 4 invokes DOE-STD-1196-2011 as the standard to use even if it has been superseded by the revised standard (DOE-STD-1196-2022). Therefore, the existing PA remains valid and use of the revised standard is not required for the facility to remain compliant. DOE Order 458.1 Chg 4 is being updated and will invoke the revised standard. The RHLLW Disposal Facility project is being proactive by evaluating potential impacts to the PA if dose coefficients from the revised standard are employed. The information will be useful in evaluating waste acceptance, performing special analyses, and planning for facility expansion and revision of the PA should it become necessary.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Thus, an evaluation of impacts to the PA from use of dose coefficients from revised standard DOE-STD-1196-2022 is recommended.

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	10/4/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Tim Arsenault	10/5/2023
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Dose calculations for the RHLLW Disposal Facility performance assessment (PA) (DOE-ID 2018) were performed using dose coefficients from standard DOE-STD-1196-2011 (DOE 2011). An evaluation was performed to determine the impacts to the RHLLW Disposal Facility PA from using dose coefficients from the revised standard, DOE-STD-1196-2022 (DOE 2022). The evaluation, documented in ECAR-7548, determined the dose coefficients in the updated standard (DOE 2022) were generally lower compared to DOE (2011). The ratio of the DOE (2022) per-capita water and the DOE (2011) reference person dose coefficient ranged from 0.072 to 1.04. Except for Nb-94, all per-capita water dose coefficients in DOE (2022) were equal to or lower than the DOE (2011) reference persons dose coefficients. No direct comparison can be made for the per-capita milk dose coefficient in DOE (2022) because per-capita milk ingestion was not included in DOE (2011).

Direct comparison of dose coefficients was revealed to be insufficient to determine the impact on the PA all-pathways dose because changes were made to the updated all-pathway dose model. These changes include:

- Revision of the approach used to determine concentrations of C-14 and H-3 in food products. The previous all-pathways dose factors used a specific activity model. The revised model used a concentration ratio/transfer coefficient approach so that per-capita milk and per-capita water dose coefficients could be utilized from the updated standard (DOE 2022).

- Water and milk ingestion rates were changed from the current all-pathways dose model of 730 L/yr for water and 112 L/yr for milk to the per-capita consumption rates of 493 L/yr for water and 72.6 L/yr for milk.

- Inclusion of the daughter isotope (Nb-93m) of Mo-93 that was not included in the original PA dose calculations.

Recalculation of the all-pathways dose using dose coefficients from the revised standard (DOE 2022) and the changes shown above revealed the all-pathways dose would go down 79% during the compliance period (from 4.38E-04 mrem/yr to 9.23E-05 mrem/yr) and 62% during the post-compliance period (0.642 mrem/yr to 0.243 mrem/yr) for the PA base case. In addition, the peak dose during the post-compliance period shifted from the receptor downgradient of the east array to the receptor downgradient of the west array. This is because during the post-compliance period, the east receptor dose is dominated by Tc-99, and the west receptor dose is dominated by I-129. The DOE (2022) per-capita water ingestion dose coefficient for Tc-99 is 84% less than the reference person water ingestion dose coefficient for Tc-99 from DOE (2011). In contrast, the DOE (2022) per-capita water ingestion dose coefficient for I-129 is only 20% less than the reference person water ingestion dose coefficient for I-129 from DOE (2011).

During recalculation of the all-pathways dose it was also revealed that Nb-93m is insignificant in terms of dose contribution and thus omitting from the original PA had no impact. For the complete evaluation including the comparison of doses using both standards, see ECAR-7548.

Because the current DOE Order 458.1 Chg 4 invokes DOE-STD-1196-2011 as the standard to use even if it has been superseded by the revised standard (DOE-STD-1196-2022), the existing PA remains valid and use of the revised standard is not required for the facility to remain compliant. Nevertheless, the RHLLW Disposal Facility project is being proactive by evaluating potential impacts to the PA if dose coefficients from the revised standard are employed. The information in ECAR-7548 will be useful in evaluating waste acceptance, performing special analyses, and planning for facility expansion and revision of the PA should it become necessary.

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Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	10/4/2023 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	10/4/23 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	10/4/2023 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul Velasquez Signature Waste Management/WMP	10/04/2023 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Tim Arsenault Signature Nuclear Facility Manger/NFM	10/5/23 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ____________________

Special Analysis Document Number: ____________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ____________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-065

Subject: UDQE-RHLLW-065, Vault Shield Plugs Exhibiting Level 3 or Greater Damage - 2022 Annual Inspection

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

As required by PLN-3368: "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," annual inspections are performed on vault shield plugs (VSP) for vaults containing waste and the VSPs adjacent to them. The "System Design Description-Remote-Handled Low-Level Waste Disposal Vault System (SDD-410)" requires inspection (and subsequent repair, if necessary) of concrete damage to be performed using criteria carried forward from facility design to operations. The criteria used during vault fabrication are documented in SPC-1857 and during vault installation in SPC-1910. Inspection criteria employed during vault fabrication included identification of concrete defects introduced during the vault fabrication process (i.e., bug holes, honeycombing, air bubble marks, cracking and seals offset) in addition to Level 1, Level 2, and Level 3 damage (e.g., spalling) to components occurring after the vault components were fabricated. During vault installation, the inspection criteria were reduced to include only the Level 1, Level 2, and Level 3 post-fabrication cracking and spalling damage (see SPC-1910) using the performance measures provided in SPC-1857. SDD-410 and SD-52.1.4: "DOE Order 435.1 Documentation Change Control Process for the RH-LLW Disposal Facility," require inspection and repair of any new Level 3 post-fabrication cracking and spalling damage using the criteria and procedures specified in SPC-1910 and carried forward into SDD-410. Level 3 damage is of importance since it has the potential to impact the functional performance of the vault shield plugs.

This UDQE is being prepared and evaluated because the 2022 annual inspection work order (WO) identified new Level 3 defects on VSPs currently installed in Array 2 at positions C1 (VLT-PLG-HF-P06), D1 (VLT-PLG-HF-P15), E1 (VLT-PLG-HF-P12), and E2, (VSP-PLG-HF-P13). These issues were identified in preventative maintenance (PM) WOs 325548 and 327459 during annual PM inspections.

- The VSP installed in the Array 2, C1 position exhibited a chip on a top corner that is approximately 2-in long by approximately 6-in wide and approximately 1-in deep.
- The VSP installed in the Array 2, D1 position exhibited three damage areas exceeding Level 3 criteria: one chip area and two cracks. The chip at the top edge is approximately 2-in long by approximately 2-in wide by approximately 1-in deep. The two cracks in the D1 VSP range from 1-in to 2-in long, a width of > 0.01-in and an approximate maximum depth of 1-in and are located near the edge of the top surface.
- The VSP installed in the Array 2, E1 position exhibited a crack approximately 6-in long, a width of > 0.01-in, and an approximate maximum depth of 1-in and is located near an edge of the top surface.
- The VSP installed in the Array 2, E2 position exhibited a chip at a top corner that is approximately 2-in long by approximately 2-in wide by approximately 1-in deep.

These defects are being evaluated in this UDQE to ensure the vaults are repaired and re-inspected per the requirements of SDD-410 using the procedures approved in SPC-1910 and implemented in Model Work Order (MWO) 258119.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☒ No ☐

Comments: Level 3 damage has the potential to impact the long-term performance of the VSP. The concrete vaults provide structural protection to the stainless-steel canisters and provide structural support of the final engineered cover. Level 3 damage must be repaired (if possible) and reinspected to ensure the VSPs meet their intended function and operability requirements.

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	12/06/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	12/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

The chip on a top corner of VSP C1 in Array 2 is approximately 2-in long by approximately 6-in wide and approximately 1-in deep. This chip did not expose rebar and is typical of other chips that have occurred previously in VSPs, which have been successfully repaired. Placement of dowels will not be required to hold the repair in place. It is located in an area that can potentially be impacted by infiltrating water. The chipped area was repaired using approved materials as required by SDD-410 and shown in SPC-1910, Section 2.2 and 2.3. Jet Set Complete Repair grout is the approved product. The repair was made by trained personnel as required by SDD-410 and per manufacturer's recommendations.

The VSP installed in the Array 2, D1 position exhibited three damage areas exceeding Level 3 criteria: one chip area and two cracks. The chip on a top edge is approximately 2-in long by approximately 2-in wide by approximately 1-in of depth. The two cracks in the D1 VSP range from 1-in to 2-in long, a width of > 0.01-in and an approximate maximum depth of 1-in and are located near the edge of the top surface. The chip did not expose rebar and is typical of other chips that have occurred previously in VSPs, which have been successfully repaired. Placement of dowels will not be required to hold the repair in place. It is located in an area that can potentially be impacted by infiltrating water. The chipped area was repaired using approved materials as required by SDD-410 and shown in SPC-1910, Section 2.2 and 2.3. Jet Set Complete Repair grout is the approved product for chips. Jet Set Smooth is the approved product for cracks. The repairs were made by trained personnel as required by SDD-410 and per manufacturer's recommendations.

The VSP installed in the Array 2, E1 position exhibited a crack approximately 6-in long, a width of > 0.01-in and an approximate maximum depth of 1-in and is located near the edge of the top surface. The cracked area was repaired using approved materials as required by SDD-410 and shown in SPC-1910, Section 2.2 and 2.3. Jet Set Smooth Repair grout is the approved product. The repair was made by trained personnel as required by SDD-410 and per manufacturer's recommendations.

The VSP installed in the Array 2, E2 position exhibited a chip at a top corner that is approximately 2-in long, a width of approximately 2-in and an approximate maximum depth of 1-in and is located near the edge of the top surface. The cracked area was repaired using approved materials as required by SDD-410 and shown in SPC-1910, Section 2.2 and 2.3. Jet Set Complete Repair grout is the approved product. The repair was made by trained personnel as required by SDD-410 and per manufacturer's recommendations.

The cracks noted above appear to be similar to the cracks evaluated in document: "Assessment of the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility Vault Concrete Data (INL/EXT-17-42239)." As required by SDD-410, the cracks were repaired using approved repair materials (see SPC-1910; Jet Set Smooth) and re-inspected prior to being placed back into service. As with cracks repaired during vault fabrication, this repair is expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance.

For all four VSPs, operability reviews were completed to ensure the characteristics important to the safety analysis have not been degraded. These reviews documented in OPR 2022-0185 and OPR 2022-0248 determined that each of the four VSPs are operable and not degraded. Maintenance Work Request MWR-2022-4857 was submitted to initiate repairs of each issue as identified above and WO 332969 was performed to complete the repairs. Re-inspection following repairs showed repairs were acceptable and met criteria to ensure there is no impact to long-term vault performance.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	12/13/2023
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	12/6/23
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	12/06/2023
Paul A. Velasquez Waste Management/WMP	Paul A. Velasquez Waste Management/WMP	12/07/2023
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	12/6/23

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

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Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-066

Subject: 2022 Annual HFEF CVAS Inspection with Level 3 or Greater Damage Identified

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

As required by PLN-3368: "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," the 2022 annual B21-632 HFEF Cask-to-Vault Adapting Structure (CVAS) inspection was performed. The "System Design Description-Remote-Handled Low-Level Waste Disposal Vault System (SDD-410)" requires inspection (and subsequent repair, if necessary) of concrete damage to be performed using criteria carried forward from facility design to operations. The criteria used during vault fabrication are documented in SPC-1857 and during vault installation in SPC-1910. Inspection criteria employed during vault fabrication included identification of concrete defects introduced during the vault fabrication process (i.e., bug holes, honeycombing, air bubble marks, cracking and seals offset) in addition to Level 1, Level 2, and Level 3 damage (e.g., spalling) to components occurring after the vault components were fabricated. During vault installation, the inspection criteria were reduced to include only the Level 1, Level 2, and Level 3 post-fabrication cracking and spalling damage (see SPC-1910) using the performance measures provided in SPC-1857. SDD-410 and SD-52.1.4: "DOE Order 435.1 Documentation Change Control Process for the RH-LLW Disposal Facility," require inspection and repair of any new Level 3 post-fabrication cracking and spalling damage using the criteria and procedures specified in SPC-1910 and carried forward into SDD-410. Level 3 damage is of importance since it has the potential to impact the functional performance of the vault shield plugs and CVAS.

This UDQE is being prepared and evaluated because the annual inspection work order (WO) 324681 identified new Level 3 defects on the HFEF CVAS as follows:

- The HFEF CVAS exhibited a crack that is approximately 0.011-in wide, and approximately 6-in long from the top edge down the face nearest the vault access port (depth was indeterminant).
- A chip defect was identified next to the access port and one of the lift pockets. It is 6-in long by about 1-in wide and approximately 1-in deep.

These defects are being evaluated in this UDQE to ensure they are acceptable for use and are repaired and inspected per the requirements of SDD-410 using the procedures approved in SPC-1910 and implemented in Model Work Order (MWO) 258120.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☒ No ☐

Comments: Level 3 damage has the potential to impact the long-term performance of the HFEF CVAS. The concrete vaults provide structural protection to the stainless-steel canisters and provide structural support of the final engineered cover. The CVAS is used in place of a vault shield plug during waste emplacement activities and may be in place for an extended but non-permanent length of time and; therefore, is treated the same as a vault shield plug. Damage to the CVAS could also potentially damage the top mating surface of the vault upper riser during use.

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments: NA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in*

the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	12/06/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	12/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required.

Explanation:

SPC-1857 identifies Level 1, Level 2 and Level 3 damage and defect types. Level 1 and Level 2 damage and defects have been determined to pose an insignificant impact to long-term vault performance (i.e., shielding, weight bearing, and long-term vault performance) if left unrepaired. Level 3 damage (i.e., new cracks, chipping and spalling) has been determined to pose a potential performance risk.

The annual inspection WO 324681 (MWO 257899) requires the HFEF and MFTC CVASs to be visually inspected for cracks, chipping, and spalling of concrete per the preventative maintenance program. As required by the annual WO, the inspection was performed and identified two Level 3 damaged areas on the HFEF CVAS as noted in the description section of this UDQE.

Evaluation of Damage:

Damages on the HFEF CVAS: The damage appears to be similar to the cracks evaluated in document: "Assessment of the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility Vault Concrete Data (INL/EXT-17-42239)." As evaluated in INL/EXT-17-42239, given the damage origin and dimensions and the fact that it is on a CVAS (a non-permanent vault component), the damages would not be expected to impact long-term vault performance. The chip area exposed no rebar and is not of significant depth to result in structural concerns per engineering judgement. This chip's dimensions are typical of previously-identified chips on other vault shield plugs, which have been successfully repaired. However, as required by SDD-410, the damages will be repaired using approved repair materials (see SPC-1910; Jet Set Smooth for cracks and Jet Set Complete for chips) and re-inspected. As with defects repaired during vault fabrication, these repairs are expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance. Additionally, Labway Operability Review OPR 2022-0173 was completed to determine if the damage could impact the CVAS safety/functional performance per SAR-419. The completed and approved review resulted in the determination that the CVAS is still functional with no impact to its safety function.

For all repairs, the requirements of SDD-410 and shown in SPC-1910, Section 2.2 and 2.3 will be followed as implemented in the model work order. The repairs were made using model routine repair WO 258120 and MWR 2022-4885 and performed by trained personnel. Repairs were successfully completed using WO 332969, which is a copy of the MWO with a unique WO number specific to this iteration; post-maintenance inspections showed no issues.

Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	12/13/2023 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	12/6/23 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	12/06/2023 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul A. Velasquez Signature Waste Management/WMP	12/07/2023 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	12/6/23 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

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Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-072

Subject: 2023 Annual HFEF CVAS Inspection with Level 3 or Greater Damage Identified

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

As required by PLN-3368: "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," the 2023 annual B21-632 HFEF Cask-to-Vault Adapting Structure (CVAS) inspection was performed. The "System Design Description-Remote-Handled Low-Level Waste Disposal Vault System (SDD-410)" requires inspection (and subsequent repair, if necessary) of concrete damage to be performed using criteria carried forward from facility design to operations. The criteria used during vault fabrication are documented in SPC-1857 and during vault installation in SPC-1910. Inspection criteria employed during vault fabrication included identification of concrete defects introduced during the vault fabrication process (i.e., bug holes, honeycombing, air bubble marks, cracking and seals offset) in addition to Level 1, Level 2, and Level 3 damage (e.g., spalling) to components occurring after the vault components were fabricated. During vault installation, the inspection criteria were reduced to include only the Level 1, Level 2, and Level 3 post-fabrication cracking and spalling damage (see SPC-1910) using the performance measures provided in SPC-1857. SDD-410 and SD-52.1.4: "DOE Order 435.1 Documentation Change Control Process for the RH-LLW Disposal Facility," require inspection and repair of any new Level 3 post-fabrication cracking and spalling damage using the criteria and procedures specified in SPC-1910 and carried forward into SDD-410. Level 3 damage is of importance since it has the potential to impact the functional performance of the vault shield plugs and CVAS.

This UDQE is being prepared and evaluated because the annual inspection work order (WO) 341837 identified new Level 3 defects on the HFEF CVAS as follows:

- The HFEF CVAS exhibited six cracks that are approximately 0.011-in wide, and approximately 1-in in length.
- Three chip defects were identified: two next to the access port and one at an upper corner. They range from about 1-in to 1.5-in wide and approximately 1-in deep.

These defects are being evaluated in this UDQE to ensure the CVAS is acceptable for use and defects are repaired and inspected per the requirements of SDD-410 using the procedures approved in SPC-1910 and implemented in Model Work Order (MWO) 258120.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☒ No ☐

Comments:

Level 3 damage has the potential to impact the long-term performance of the HFEF CVAS. The concrete vaults provide structural protection to the stainless-steel canisters and provide structural support of the final engineered cover. The CVAS is used in place of a vault shield plug during waste emplacement activities and may be in place for an extended but non-permanent length of time and; therefore, is treated the same as a vault shield plug. Damage to the CVAS could also potentially damage the top mating surface of the vault upper riser during use.

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments: NA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	12/06/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	12/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required.

Explanation:

SPC-1857 identifies Level 1, Level 2 and Level 3 damage and defect types. Level 1 and Level 2 damage and defects have been determined to pose an insignificant impact to long-term vault performance (i.e., shielding, weight bearing, and long-term vault performance) if left unrepaired. Level 3 damage (i.e., new cracks, chipping and spalling) has been determined to pose a potential performance risk.

The annual inspection WO 341837 (MWO 257899) requires the HFEF and MFTC CVASs to be visually inspected for cracks, chipping, and spalling of concrete per the preventative maintenance program. As required by the annual WO, the inspection was performed and identified Level 3 damaged areas on the HFEF CVAS as noted in the description section of this UDQE.

Evaluation of Damage:

Damages on the HFEF CVAS: The damage appears to be similar to the cracks evaluated in document: "Assessment of the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility Vault Concrete Data (INL/EXT-17-42239)." As evaluated in INL/EXT-17-42239, given the damage origin and dimensions and the fact that it is on a CVAS (a non-permanent vault component), the damages would not be expected to impact long-term vault performance. The chip areas exposed no rebar and are not of significant depth to result in structural concerns per engineering judgement. The chips' dimensions are typical of previously-identified chips on other CVAS and vault shield plugs, which have been successfully repaired. However, as required by SDD-410, the damages will be repaired using approved repair materials (see SPC-1910; Jet Set Smooth for cracks and Jet Set Complete for chips) and re-inspected. As with defects repaired during vault fabrication, these repairs are expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance. Additionally, Labway Operability Review OPR 2023-0147 was completed to determine if the damage could impact the CVAS safety/functional performance per SAR-419. The completed and approved review resulted in the determination that the CVAS is still functional with no impact to its safety function.

For all repairs, the requirements of SDD-410 and shown in SPC-1910, Section 2.2 and 2.3 were followed as implemented in the model work order. The repairs were made using model routine repair WO 258120 and MWR 2023-3566 and performed by trained personnel. Repairs were successfully completed using WO 342641, which is a copy of the MWO with a unique WO number specific to this iteration; post-maintenance inspections showed no issues.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	12/13/2023
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	12/6/23
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	12/06/2023
Paul A. Velasquez Waste Management/WMP	Paul A. Velasquez Waste Management/WMP	12/07/2023
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	12/6/23

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ____________________

Special Analysis Document Number: ____________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ____________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-073

Subject: UDQE-RHLLW-073, Vault Shield Plugs Exhibiting Level 3 or Greater Damage - 2023 Annual Inspection

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

As required by PLN-3368: "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," annual inspections are performed on vault shield plugs (VSP) for vaults containing waste and the VSPs adjacent to them. The "System Design Description-Remote-Handled Low-Level Waste Disposal Vault System (SDD-410)" requires inspection (and subsequent repair, if necessary) of concrete damage to be performed using criteria carried forward from facility design to operations. The criteria used during vault fabrication are documented in SPC-1857 and during vault installation in SPC-1910. Inspection criteria employed during vault fabrication included identification of concrete defects introduced during the vault fabrication process (i.e., bug holes, honeycombing, air bubble marks, cracking and seals offset) in addition to Level 1, Level 2, and Level 3 damage (e.g., spalling) to components occurring after the vault components were fabricated. During vault installation, the inspection criteria were reduced to include only the Level 1, Level 2, and Level 3 post-fabrication cracking and spalling damage (see SPC-1910) using the performance measures provided in SPC-1857. SDD-410 and SD-52.1.4: "DOE Order 435.1 Documentation Change Control Process for the RH-LLW Disposal Facility," require inspection and repair of any new Level 3 post-fabrication cracking and spalling damage using the criteria and procedures specified in SPC-1910 and carried forward into SDD-410. Level 3 damage is of importance since it has the potential to impact the functional performance of the vault shield plugs.

This UDQE is being prepared and evaluated because the 2023 annual inspection work order (WO) identified new Level 3 defects on the VSPs currently installed in Array 2 at position D2, and Array 3 positions C4 and C5. These issues were identified in PM WO 342129 during annual preventive maintenance inspections.

- Array 2 Position D2 VSP chip is approximately 5-in long by 3-in wide by about 1-in deep.
- Array 3 Position C4 VSP has three chip areas ranging from 4-in by 2-1/2-in, 2-1/2-in by 1-1/2-in, and 1-3/4-in by 1-1/2-in. Depths range from 1/8-in to ½-in.
- Array 3 Position C5 VSP has a chipped area approximately 6-in long by 4-in wide by ¼-in deep.

These defects are being evaluated in this UDQE to ensure the vaults are repaired and re-inspected per the requirements of SDD-410 using the procedures approved in SPC-1910 and implemented in Model Work Order (MWO) 258119.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☒ No ☐

Comments: Level 3 damage has the potential to impact the long-term performance of the VSP. The concrete vaults provide structural protection to the stainless-steel canisters and provide structural support of the final engineered cover. Level 3 damage must be repaired (if possible) and reinspected to ensure the VSPs meet their intended function and operability requirements.

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Print/Type Name	Signature	Date
Jonathan Jacobson	Jonathan Jacobson	12/06/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	12/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

All of the chips did not expose rebar and are typical of other chips that have occurred previously in VSPs, which have been successfully repaired. Placement of dowels will not be required to hold the repairs in place. They are located in areas that can potentially be impacted by infiltrating water. The chipped areas were repaired using approved materials as required by SDD-410 and shown in SPC-1910, Section 2.2 and 2.3. Jet Set Complete Repair grout is the approved product for chips. The repairs were made by trained personnel as required by SDD-410 and per manufacturer's recommendations.

The chipped areas noted above appear to be similar to those evaluated in document: "Assessment of the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility Vault Concrete Data (INL/EXT-17-42239)." As required by SDD-410, the chipped areas are repaired using approved repair materials (see SPC-1910; Jet Set Complete) and re-inspected prior to being placed back into service. As with chips repaired during vault fabrication, these repairs are expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance.

For all three VSPs, an operability review was completed to ensure the characteristics important to the safety analysis have not been degraded. The review documented in OPR 2023-0173 determined that each of the three VSPs are operable and not degraded. Repairs were completed using WO 349402. Re-inspection following repairs showed repairs were acceptable and met criteria to ensure there is no impact to long-term vault performance.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	12/13/2023
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	12/6/23
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	12/06/2023
Paul A. Velasquez Waste Management/WMP	Paul A. Velasquez Waste Management/WMP	12/07/2023
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	12/6/23

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-079

Subject: NRF New Projected RWDS Radionuclide Inventory for Modules with Extended Service Life

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Naval Reactors Facility (NRF) is proposing to extend the service life of Radioactive Water Demineralizer System (RWDS) modules in the Expended Core Facility (ECF) water pool and the Naval Spent Fuel Handling (NSFH) Facility water pool when it becomes operable. NRF indicated this could impact/change the base case inventory of radionuclides on NRF resins used for the RHLLW Disposal Facility performance assessment (PA) dose calculations. As a result, NRF provided RHLLW Disposal Facility personnel with a new revised 20-yr estimate of radionuclides on NRF resins assuming the service life of RWDS modules would be extended. This new revised RWDS resin inventory is documented in Nelson (2023). The primary purpose of this UDQE is to determine the potential impact of the new revised 20-yr inventory estimate on the PA.

In addition to evaluating impacts to the PA, the impact of hypothetical maximum RWDS module inventories with extended service life on the RHLLW Disposal Facility safety basis were assessed to determine if the dose consequences for cask/canister fire and drop accidents are within the bounds of the safety basis for handling and disposal at the RHLLW Disposal Facility.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

   Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☒ No ☐

   Comments: The CA is based on a de minimus contribution from the RHLLW Disposal Facility. While it is doubtful, it is possible the change in NRF resin inventory could impact the effective dose of the PA enough to challenge the conclusions of the CA and should be evaluated.

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

   Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC)*

from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Extending the life of the RWDS modules will change the PA base case resin inventory for NRF which is an input to the PA. The new revised inventory should be evaluated to determine if it is within the bounds of the approved PA. Hypothetical maximum canister inventories for RWDS modules with extended service life should also be evaluated to determine if dose consequences for canister fire and drop accidents are within the bounds of the safety basis for handling and disposal at the RHLLW Disposal Facility.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: An evaluation is recommended to determine if the estimated change in the NRF RWDS resin inventory is within the bounds of the approved PA.

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

A. Jeff Sondrup	Jeff Sondrup Jeff Sondrup (Sep 24, 2024 22:10 MDT)	Sep 24, 2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault Timothy Arsenault (Sep 25, 2024 09:12 MDT)	Sep 25, 2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments: See explanation below.

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments: See explanation below.

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:
This explanation consists of:

- An evaluation of potential impacts to the RHLLW Disposal Facility PA (pages 5-11), and
- An evaluation of potential impacts to the facility safety basis (pages 11-12).

<u>Evaluation of Potential Impacts to the RHLLW Disposal Facility PA</u>
NRF Waste Programs provided a conservative estimate of the radionuclide inventory for RWDS modules with extended service life that could be generated and shipped to the RHLLW Disposal Facility over a 20-yr period (see Nelson 2023). This new RWDS radionuclide inventory includes the inventory of an estimated 24 modules from the ECF water pool and 32 modules from the NSFH Facility water pool. The 32 modules from the NSFH Facility water pool is believed to be a conservative (high) estimate for a 20-yr period.

NRF calculated the radionuclide inventory of a single RWDS module from the ECF water pool using survey data and an estimated "worst case" Co-60 content from an RWDS module that had been in the ECF water pool for 12 years and located in an area of the pool that has historically produced RWDS modules with the highest levels of contamination. The inventory of this canister was multiplied by 24 to obtain a 20-yr inventory estimate of activities in ECF RWDS modules. The 20-yr estimate for the 32 NSFH Facility RWDS modules was obtained by multiplying the inventory of a single ECF RWDS module by 3[1], the approximate ratio of the NSFH Facility waste canister volume to the 55-Ton waste canister volume, and then by 32, the estimated number of RWDS modules to come from the NSFH Facility water pool. Although NRF multiplied these numbers by a factor of 2 as a "buffer" to account for uncertainty and to be conservative (see Nelson 2023), this UDQE will use the inventories prior to applying the buffer of 2. This is consistent with the methodology for estimating the PA base case inventories. Estimates using "buffers" or safety factors to account for uncertainty were addressed in the uncertainty and sensitivity section of the PA (DOE-ID 2018). Additionally, there is already conservativism in the estimates prior to applying the factor of 2 because the number of modules expected to be shipped was conservatively estimated and the inventories were derived using information from an RWDS module placed in a more highly contaminated area of the water pool.

The new projected total 20-yr RWDS radionuclide inventory is shown in Table 1 (columns 1 and 2). For comparison purposes, Table 1 also contains the PA base case RWDS inventory (column 3), the PA base case resin inventory for all generators [includes resins from Advanced Test Reactor (ATR) and NRF] (column 5), and the PA base case inventory for all generators and waste forms (column 7). The new RWDS inventory was compared to these other inventories using ratios to determine if the new RWDS inventory is within the bounds of the approved PA. These comparisons and other observations from Table 1 are discussed below.

[1] The volume ratio of the waste canisters is used as a surrogate for the activity ratio of the NSFH and ECF RWDS modules. The volume of an NSFH waste canister is approximately 7 m^3. The volume of an ECF (55-ton) canister is approximately 2.5 m^3. The ratio of canister volumes is 7/2.5 = 2.8. A value of 3 was used for conservatism.

Table 1. RWDS 20-yr inventory comparison summary.

1	2	3	4	5	6	7	8	9
Nuclide	New RWDS Inventory (Ci)[a]	RHLLW PA Base Case RWDS Inventory (Ci)	Ratio New RWDS to RHLLW PA Base Case RWDS Inventory	RHLLW PA Base Case All Resins Inventory (Ci)	Ratio New RWDS to RHLLW PA Base Case Inventory All Resins and Generators	RHLLW PA Base Case Inventory All Generators and Waste Forms (Ci)	Ratio New RWDS to RHLLW PA Base Case Inventory All Waste Forms and Generators	Phase Screened Out in PA Groundwater Pathway Assessment
Am-241	2.55E-01	4.97E-04	**512**	1.39E-02	**18.3**	2.79E-01	**0.91**	III
Am-242m	1.58E-04	3.10E-06	**51.0**	3.10E-06	**51.0**	1.82E-03	0.087	III
Am-243	2.44E-04	1.07E-05	**22.8**	1.07E-05	**22.8**	5.36E-04	**0.46**	III
C-14	9.75E+01	7.76E-02	**1,257**	1.06E+00	**92.0**	2.14E+02	0.46	Retained
Cf-249[b]	4.02E-11	0	#DIV/0!		#DIV/0!	3.71E-12	**10.8**	II
Cf-251[b]	1.62E-12	0	#DIV/0!		#DIV/0!	1.09E-13	**14.8**	II
Cm-242	5.41E-05	4.35E-06	**12.4**	1.71E-03	0.032	1.02E+01	0.0000053	I
Cm-243	1.96E-02	8.81E-06	**2,219**	8.81E-06	**2,220**	1.25E-03	**15.6**	III
Cm-244	2.27E-02	6.09E-04	**37.3**	9.99E-03	**2.27**	3.21E-02	**0.71**	III
Cm-245[b]	2.03E-06	0	#DIV/0!		#DIV/0!	5.27E-07	**3.85**	II
Cm-246[b]	8.13E-07	0	#DIV/0!		#DIV/0!	3.52E-07	**2.31**	II
Cm-247[b]	2.44E-12	0	#DIV/0!		#DIV/0!	1.64E-13	**14.9**	II
Cm-248[b]	7.75E-12	0	#DIV/0!		#DIV/0!	5.19E-13	**14.9**	II
Co-58	8.76E+00	5.75E+00	**1.52**	5.21E+01	0.168	2.64E+04	0.00033	I
Co-60	3.74E+03	1.62E+03	**2.30**	1.85E+03	**2.02**	3.10E+05	0.012	III
Cr-51	2.75E+01	1.43E+01	**1.92**	6.40E+02	0.043	5.58E+03	0.0049	I
Cs-134	2.24E-01	1.72E+00	0.130	2.40E+00	0.093	1.06E+02	0.0021	III
Cs-137	5.46E+01	8.13E+00	**6.71**	1.43E+01	**3.81**	9.46E+02	0.058	III
Eu-152	2.29E+00	3.47E+00	0.660	4.01E+00	0.572	4.14E+00	**0.55**	III
Eu-154	2.73E+00	1.12E+01	0.245	1.18E+01	0.231	1.56E+01	**0.18**	III
Fe-55	6.94E+02	3.64E+03	0.191	4.03E+03	0.172	1.96E+05	0.0035	III
Fe-59	1.49E+01	2.26E+00	**6.59**	2.06E+01	0.722	6.17E+02	0.024	I
H-3	3.01E+00	3.75E+00	0.801	3.86E+00	0.778	1.98E+03	0.0015	Retained
Hf-175	1.68E+01	1.41E+00	**11.9**	1.48E+00	**11.4**	1.53E+02	**0.11**	I
Hf-181	1.54E+01	5.55E+00	**2.77**	6.42E+00	**2.39**	6.87E+01	**0.22**	I
I-129	3.25E-04	1.82E-06	**179**	5.33E-02	0.0061	5.38E-02	0.0060	Retained
Kr-85	1.11E-01	7.65E-01	0.145	7.65E-01	0.145	5.04E+01	0.0022	I
Mn-54	3.88E+01	6.56E+00	**5.92**	2.88E+01	**1.35**	2.04E+04	0.0019	I
Nb-93m	9.44E+01	8.47E-05	**1,114,116**	8.47E-05	**1,114,522**	5.70E+02	**0.17**	III
Nb-94	1.63E+00	2.03E-09	**800,888,763**	8.48E-01	**1.92**	5.71E+01	0.028	Retained
Nb-95	4.89E+00	2.06E+01	0.237	2.55E+01	0.192	7.91E+04	0.000062	I
Ni-59	2.44E+01	1.12E+01	**2.19**	1.19E+01	**2.05**	1.82E+03	0.013	Retained
Ni-63	2.34E+03	1.41E+03	**1.67**	1.44E+03	**1.63**	2.19E+05	0.011	III
Np-237	2.98E-07	1.48E-05	0.0202	1.07E-04	0.0028	6.95E-04	0.00043	Retained
Pu-238	1.28E+00	1.45E-01	**8.81**	1.56E-01	**8.21**	3.68E-01	**3.49**	III
Pu-239	5.57E-02	1.02E-04	**54,767%**	2.89E-02	**1.93**	5.57E-01	0.10	Retained
Pu-240	2.05E-03	2.08E-04	**9.86**	2.01E-03	**1.02**	1.76E-01	0.012	Retained
Pu-241	6.11E-01	4.30E-02	**14.2**	4.45E-02	**13.7**	1.98E+01	0.031	III
Pu-242	2.44E-05	1.62E-06	**15.1**	1.62E-06	**15.0**	2.27E-04	**0.11**	III
Pu-244[b]	3.66E-12	0	#DIV/0!		#DIV/0!	5.11E-13	**7.15**	II
Sb-125	5.30E+01	3.28E+01	**1.61**	3.29E+01	**1.61**	2.27E+04	0.0023	III
Se-79	1.22E-05	3.64E-05	0.335	3.64E-05	0.335	9.59E-03	0.0013	III
Sn-126[b]	3.66E-05	0	#DIV/0!		#DIV/0!	5.05E-02	0.00072	III
Sr-90	2.23E+01	8.29E+00	**2.69**	2.45E+01	0.911	6.73E+02	0.033	III
Tc-99	3.35E+00	5.55E-02	**60.3**	2.03E+00	**1.65**	5.24E+00	0.64	Retained
Te-125m	1.22E+01	7.97E+00	**1.54**	7.99E+00	**1.53**	5.55E+03	0.0022	I
Th-232[b]	7.75E-09	0	#DIV/0!		#DIV/0!	2.48E-07	0.031	II
U-232[b]	1.15E-04	0	#DIV/0!		#DIV/0!	2.31E-04	**0.50**	III
Zn-65[b]	1.07E+01	0	#DIV/0!	3.25E+01	0.339	6.00E+01	**0.18**	I
Zr-93	1.63E-02	3.08E-04	**52.7**	1.86E-02	0.874	2.22E+01	0.00073	III
Zr-95	1.21E+01	1.26E+01	0.964	1.57E+01	0.772	3.59E+04	0.00034	I
Totals	**7,301**	**6,825**		**8,262**		**927,776**		

a. Includes estimated inventory for 24 ECF and 32 NSFH Facility RWDS modules.
b. Blue highlighted cells in columns 1 and 2 indicate new radionuclides not included in PA base case RWDS inventory.
Bold red font indicates new RWDS inventory (column 2) greater than the comparison inventories (columns 3, 5 and 7).
Bold blue font indicates new RWDS inventory between 10% and 100% of PA base case total inventory (column 7) and not a key radionuclide in the PA.

1. Total Activity Comparison
   The total activity of radionuclides in the new 20-year inventory projection for RWDS resin modules increased 7% from the PA base case (6825 Ci to 7301 Ci, see last row of Table 1). Of the three nuclides with the greatest activity, the Fe-55 activity decreased significantly (3636 Ci to 694 Ci), while the Co-60 and Ni-63 activity increased. The Co-60 activity increased from 1623 Ci to 3740 Ci, and the Ni-63 activity increased from 1407 Ci to 2344 Ci.

2. Radionuclides Removed from PA Base Case RWDS Inventory
   The new RWDS inventory does not include 25 radionuclides that were in the PA base case inventory of 65 radionuclides for RWDS resin modules. They are: **Am-242, Ba-137m, Ce-144, Co-57, Eu-155, Gd-153, In-113m, Mo-99, Np-238, Np-239, Pm-147, Pr-144, Rh-106, Ru-106, Sm-151, Sn-113, Sr-89, Ta-182, U-234, U-235, U-236, U-237, U-238, Y-90** and **Y-91**. Three of these (**U-234, U-235** and **U-238**) are key radionuclides in the RHLLW Disposal Facility PA. The 25 radionuclides dropped from the PA base case RWDS inventory are not shown in Table 1.

3. Radionuclides Added to New RWDS Inventory
   The new RWDS inventory includes 11 radionuclides that were not in the PA base case for RWDS resin modules. They are: **Cf-249, Cf-251, Cm-245, Cm-246, Cm-247, Cm-248, Pu-244, Sn-126, Th-232, U-232,** and **Zn-65** and are highlighted blue in columns 1 and 2. None of the 11 are key radionuclides in the RHLLW Disposal Facility PA.

4. Comparison of New RWDS Inventory (Column 2) to PA Base Case RWDS Inventory (Column 3)
   There are 40 radionuclides that are common to the PA base case inventory and new inventory for RWDS resins (radionuclides not shaded blue in column 1). Of these 40, the new RWDS inventory decreased for 10 radionuclides, and increased for 30 radionuclides when compared to the PA base case inventory for RWDS resins. The ratios are shown in column 4 which is column 2 ÷ column 3. Ratios less than one indicate the new RWDS inventory is less than the PA base case RWDS inventory. Ratios greater than 1 indicate the new RWDS inventory is greater than the PA base case RWDS inventory for that radionuclide. These are shown with a bold red font. The largest increases were for Tc-99 (+6,030%), I-129 (17,900%), Am-241 (+51,200%), Pu-239 (+54,800%), C-14 (+126,000%), Cm-243 (+222,000%), Nb-93m (+111,000,000%), and Nb-94 (+80,100,000,000%). Because many of the increases are substantial, further comparisons and evaluations were deemed necessary.

5. Comparison of New RWDS Inventory (Column 2) to PA Base Case Resin Inventory from All Generators (Column 5)
   Because the new RWDS inventory exceeded the PA base case RWDS inventory for 30 radionuclides (not including the 11 new radionuclides), the new RWDS inventory (column 2) was compared to the PA base case inventory of resins from all generators (ATR and NRF, column 5). This comparison is helpful because the PA treats all radionuclides on resins the same in terms of release and transport in the environment, regardless of the generator. However, it should be noted that the dose impact is not the same because the ATR resins are all in a west side array while the NRF resins are in both west and east arrays. The ratios (shown in column 6 which is column 2 ÷ column 5) indicate the new RWDS inventory is greater than the PA base case total resin inventory (from both ATR and NRF) for 23 radionuclides. It is encouraging that the number of radionuclides with ratios greater than 1 has gone from 30 when compared to the PA base case RWDS inventory, to 23 when compared to the PA base case total resin inventory. This means that for 7 of the 30 radionuclides, the ATR contribution is significant compared to the NRF contribution. Nevertheless, further evaluation of the new RWDS inventory was deemed necessary.

6. Comparison of New RWDS Inventory (Column 2) to PA Base Case Total Inventory (All Generators and Waste Forms) (Column 7)
   Because the new RWDS inventory exceeded the PA base case resin inventory for 23 radionuclides (not including the 11 new radionuclides), the new RWDS inventory was compared to the PA base case total

inventory of all waste forms from all generators (column 7). The ratios (shown in column 8 which is column 2 ÷ column 7) indicates the new RWDS inventory is greater than the total PA base case total inventory of all waste forms from all generators for 9 radionuclides. This includes the 11 new radionuclides because the 11 new radionuclides are included in the PA base case inventory in other waste forms. Seven of the 9 radionuclides are new radionuclides in the RWDS inventory that were not included in the PA base case RWDS inventory. These are Cf-249, Cf-251, Cm-245, Cm-246, Cm-247, Cm-248, and Pu-244). The other 2 radionuclides are Cm-243 and Pu-238. The inventory of these 9 radionuclides in the new RWDS inventory will increase the PA base case total inventory. Therefore, the increased inventories were evaluated to determine if the radionuclides would still be screened out by the PA screening. In addition to the 9 radionuclides with ratios > 1, this evaluation was performed for all radionuclides with a ratio > 0.1. In other words, radionuclides in the new RWDS inventory with activities greater than 10% of the PA total base case activities were reevaluated using the PA screening criteria. This includes 11 radionuclides in column 8 of Table 1 shown in bold blue font (Am-241, Am-243, Cm-244, Eu-152, Eu-154, Hf-175, Hf-181, Nb-93m, Pu-242, U-232, and Zn-65). This evaluation is discussed below (see "PA Screening Evaluation of Radionuclides in New RWDS Inventory" below).

Although the Hf-175, Hf-181, and Zn-65 ratios are > 0.1, they are not included in the PA screening evaluation because they were screened out in Phase I which is based on half-life and not the inventory. Key radionuclides (shown as "Retained" in column 9 of Table 1) with ratios > 0.1 are also not included in the screening evaluation because they were not screened out and their impact is included in the PA calculations of the groundwater all-pathways dose. This includes C-14 (ratio = 0.46) and Tc-99 (ratio = 0.64). Because the increased inventory of these radionuclides will increase the PA dose, they were also evaluated. This evaluation is also discussed below (see "Evaluation of Key Radionuclides on PA Dose Calculations"). It should be noted that all references to dose in this evaluation refer to the groundwater all-pathways dose unless otherwise indicated. In addition to being a key radionuclide for the groundwater pathway, C-14 is also a key radionuclide for the air pathway. This is addressed below. New RWDS inventories of key intruder pathway radionuclides (Co-60, Cs-137, Nb-94, Ni-63 and Sr-90) when compared to the PA total base case inventory values range from 1.1% (Ni-63) to 5.8% (Cs-137), and thus the impact of the new RWDS inventory on the intruder pathway is minimal and within the bounds of the current PA.

<u>PA Screening Evaluation of Radionuclides in New RWDS Inventory</u>

Radionuclides in the new RWDS inventory whose activities are greater than 10% of the total PA base case inventories were evaluated to determine if the radionuclide would still be screened out after addition of the new RWDS inventory. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the new RWDS inventories were added to the total PA base case inventories. This is conservative because the total PA base case inventory includes the base case RWDS inventory contribution of some radionuclides. This is the case for Am-241, Am-243, Cm-243, Cm-244, Eu-152, Eu-154, Nb-93m, Pu-238, and Pu-242. All others were not included in the RWDS base case inventory.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) is calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) is calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}(\frac{mrem}{yr})} \qquad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide *i* (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide *i* based on total PA base case inventory of radionuclide *i*.

Table 2 shows the results of the screening evaluation and reveals that even if the new RWDS inventory (column 2) is added to the total PA base inventory (column 3), the sums (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (columns 7 and 8). Thus, these radionuclides would still be screened out and would not be included in the PA all-pathways dose calculation.

Table 2. Comparison of radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened Durning PA Phase II Screening							
Nuclide	**New RWDS Resin Inventory (Ci)**	**Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[a]**	**Ratio New RWDS Inventory to Total PA Base Case Inventory[f]**	**New RWDS Resin Inventory + Total PA Base Case Inventory (Cols 2+3) (Ci)**	**PA Phase II NCRP Screening Factor (mrem/Ci)[b]**	**Max Allowable Phase II Screening Inventory (Ci/yr)[c]**	**RWDS Resin Inventory + Total PA Base Case Inventory as % of Max Allowable Phase II Screening Inventory[g]**
Cf-249	4.02E-11	3.71E-12	**10.8**	4.39E-11	55,500	7.21E-06	0.0006%
Cf-251	1.62E-12	1.09E-13	**14.8**	1.73E-12	48,100	8.32E-06	0.000021%
Cm-245	2.03E-06	5.28E-07	**3.85**	2.56E-06	62,900	6.36E-06	40.2%
Cm-246	8.13E-07	3.52E-07	**2.31**	1.16E-06	30,000	1.33E-05	8.7%
Cm-247	2.44E-12	1.64E-13	**14.9**	2.60E-12	55,500	7.21E-06	0.000036%
Cm-248	7.75E-12	5.18E-13	**15.0**	8.26E-12	111,000	3.60E-06	0.00023%
Pu-244	3.66E-12	5.11E-13	**7.15**	4.17E-12	115,000	3.48E-06	0.00012%
Radionuclides Screened Durning PA Phase III Screening							
Nuclide	**New RWDS Resin Inventory (Ci)**	**Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[a]**	**Ratio New RWDS Inventory to Total PA Base Case Inventory[f]**	**RWDS Resin Inventory + Total PA Base Case Inventory (Cols 2+3) (Ci)**	**PA Phase III Screening Dose (mrem/yr)[d]**	**Max Allowable Phase II Screening Inventory (Ci/yr)[e]**	**RWDS Resin Inventory + Total PA Base Case Inventory as % of Max Allowable Phase III Screening Inventory[g]**
Am-241	2.55E-01	2.79E-01	**0.91**	5.33E-01	1.84E-02	6.07E+00	8.8%
Am-243	2.44E-04	5.35E-04	**0.46**	7.68E-04	4.27E-05	5.01E+00	0.015%
Cm-243	1.96E-02	1.25E-03	**15.6**	2.08E-02	1.00E-40	5.00E+36	4.16E-37%
Cm-244	2.27E-02	3.20E-02	**0.71**	5.41E-02	1.00E-40	1.28E+38	4.23E-38%
Eu-152	2.29E+00	4.14E+00	**0.55**	2.96E+00	1.00E-40	1.66E+40	1.79E-38%
Eu-154	2.73E+00	1.56E+01	**0.18**	7.18E+00	1.00E-40	6.24E+40	1.15E-38%
Nb-93m	9.44E+01	5.70E+02	**0.17**	6.64E+02	1.00E-40	2.28E+42	2.91E-38%
Pu-238	1.28E+00	3.68E-01	**3.49**	1.50E+00	2.57E-02	5.73E+00	26.3%
Pu-242	2.44E-05	2.27E-04	**0.11**	2.50E-04	1.50E-02	6.05E-03	4.13%

a. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
b. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
c. $Imax_{II}$ from Equation 1 above.
d. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
e. $Imax_{III}$ from Equation 2 above.
f. Ratio > 1 shown in **bold red font** indicates inventory in new RWDS inventory is greater than the total PA base case inventory of this radionuclide. Other radionuclides with ratios > 0.1 are shown in **bold blue font**, indicating the new RWDS inventory is more than 10% of the total PA base case inventory.
g. Orange highlighted cells indicate new RWDS inventory + total PA base case inventory is greater than 10% of allowable screening level.

Evaluation of Key Radionuclides on PA Dose Calculations

C-14 and Tc-99 are key radionuclides in the PA. The inventory of these radionuclides in the new RWDS inventory would increase the PA total base case inventory for these radionuclides 46% for C-14 and 64% for Tc-99 (see Table 1, column 8). As a result, the increased inventories were evaluated to determine if they are within the bounds of the PA.

Groundwater Pathway

C-14 and Tc-99 are key radionuclides for the groundwater pathway. Table 3 shows the maximum potential impact on PA groundwater all-pathways doses for the east-side receptor for these two radionuclides if the PA doses are increased 46% for C-14 and 64% for Tc-99 due to the new RWDS inventory. Results for the east side receptor are shown because the maximum dose occurs at the east side receptor location. The increases in dose are small compared the performance objective (25 mrem/yr) and the actual impacts would be less for the following reasons:

- The new RWDS inventory is considered conservative for the following reasons:
  - the 32 RWDS modules generated from NSFH Facility water pool operations is likely to be less,
  - the new RWDS inventory is based on a "worst case" Co-60 reading from surveys of an RWDS module coming from an area in the water pool that has historically contained higher levels of contamination.
- The increased dose includes the impact from both the original RWDS inventory and the new RWDS inventory.
- The maximum PA doses are on the east side (downgradient of the east vault arrays) and this evaluation assumes the entire new RWDS inventory would be placed in the east vault array which is not the case. It will be split between the 55-Ton vault array (west side) and the LCC array (east side). The split is not even, but significant amounts will be placed in both arrays.
- This evaluation assumes peak radionuclide concentrations in the aquifer from the new RWDS inventory will occur at the same time as maximum doses from all other waste forms which is conservative, but very unlikely.

Based on this evaluation, increased inventories of C-14 and Tc-99 in the new RWDS inventory are within the bounds of the PA.

Table 3. Potential increases to the peak groundwater all-pathways effective dose in the aquifer 100 m downgradient from the east-side source zone due to new RWDS inventory.

Radionuclide (Progeny)	Institutional Control[a] (2039-2139)		Compliance Period (2139-3039)		Post Compliance Period (Greater than 3039)	
	EDE (mrem/year)	Time (year)	EDE (mrem/year)	Time (year)	EDE (mrem/year)	Time (year)
PA Base Case Values						
C-14	6.13E-27	2139	1.05E-13	3039	4.96E-02	24,789
Tc-99	2.10E-16	2139	4.38E-04	3039	6.33E-01	21,739
PA Base Case Values Increased 46% for C-14 and 64% for Tc-99						
C-14	8.95E-27	2139	1.53E-13	3039	7.24E-02	24,789
Tc-99	3.44E-16	2139	7.18E-04	3039	1.04E+00	21,739

a. The point of compliance during the institutional control period is the INL Site boundary; however, because doses at the 100-m location were less than 1E-10 mrem/year, doses were not calculated at the INL boundary.

Air Pathway

C-14 is a key radionuclide for the air pathway in the PA and was the primary dose contributor. The air pathway was screened out in the PA because the maximum total dose for a very conservative scenario was 0.012 mrem/yr which is significantly less than the performance objective (10 mrem/yr from all sources). The C-14 contribution to this dose was 0.011 mrem/yr or 92 % of the maximum total dose (see DOE-ID

2018, Table 2-24). The other 8% (8.32E-04 mrem/yr) is from H-3 and I-129. If the inventory of C-14 were to increase by 46%, the maximum potential total dose would increase to 0.017 mrem/yr (0.011 x 1.46 + 8.32E-04). This is still well below the performance objective and within the bounds of the PA.

Conclusion and Recommendation Regarding Potential Impacts to the PA
Based on the calculations and comparisons in this evaluation, the new RWDS module inventories are within the bounds of the PA.

It is recommended that Table B-7 of PLN-5446, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," be updated to include the 11 radionuclides reported in Nelson (2023) that were not previously reported in the NRF PA base case resin inventory. These are **Cf-249, Cf-251, Cm-245, Cm-246, Cm-247, Cm-248, Pu-244, Sn-126, Th-232, U-232,** and **Zn-65**. Given that the NRF water pool is reanalyzed every 3 years, it is possible that radionuclides in the original inventory but not in the new inventory could return. Therefore, the 25 radionuclides that were dropped from the new RWDS resin inventory can be kept in Table B-7 but a footnote should be added explaining that these radionuclides were included in the original inventory, but not in the new revised inventory. The footnote should also explain that the radionuclides could change based on continued reevaluation of the NRF water pool chemistry every three years.

Evaluation of Potential Impacts to the Facility Safety Basis
Radiation dose consequences in support of hazard evaluations and accident analyses developed for the RHLLW Disposal Facility safety basis are documented in "*Evaluation of Facility Inventory and Radiological Consequences to Support RHLLW Disposal Facility Safety Basis*" (ECAR-1559). This UDQE contains a recalculation of dose consequences based on revised canister-specific bounding activities for RWDS modules with extended service life. The revised dose consequences were assessed to determine if they were within the bounds of the current dose consequences in ECAR-1559.

Canister-specific bounding activities for an ECF RWDS module with an extended service life were provided by NRF (see email Alan Nelson to A.J. Sondrup 1-22-2024). Canister-specific bounding activities for the NSFH Facility RWDS module were determined by multiplying the ECF RWDS module bounding activities by the ratio of an NSFH Facility waste canister volume to the 55-ton canister volume (7/2.5=2.8, see footnote 1 on page 5) (see email A.J. Sondrup to Alan Nelson 2-7-2024). The bounding activities shown in Table 4 were considered material-at-risk (MAR) for the accident dose consequence calculations.

Table 4. Hypothetical maximum canister inventory for NRF RWDS modules based on proposed service-life extension.

Nuclide	ECF (55-ton) RWDS module (Ci)	NSFH RWDS Module (Ci)
Am-241	1.08E-02	3.02E-02
Am-242m	6.70E-06	1.88E-05
Am-243	1.03E-05	2.89E-05
C-14	4.14E+00	1.16E+01
Cf-249	1.70E-12	4.77E-12
Cf-251	6.86E-14	1.92E-13
Cm-242	2.29E-06	6.42E-06
Cm-243	8.29E-04	2.32E-03
Cm-244	9.62E-04	2.69E-03
Cm-245	8.61E-08	2.41E-07
Cm-246	3.44E-08	9.64E-08
Cm-247	1.03E-13	2.90E-13
Cm-248	3.27E-13	9.17E-13
Co-58	3.72E-01	1.04E+00
Co-60	1.59E+02	4.44E+02
Cr-51	1.17E+00	3.27E+00
Cs-134	9.49E-03	2.66E-02
Cs-137	2.31E+00	6.48E+00
Eu-152	9.73E-02	2.72E-01
Eu-154	1.16E-01	3.24E-01
Fe-55	2.94E+01	8.22E+01
Fe-59	6.30E-01	1.77E+00
H-3	1.28E-01	3.57E-01
Hf-175	7.12E-01	1.99E+00
Hf-181	6.51E-01	1.82E+00
I-129	1.38E-05	3.86E-05
Kr-85	4.71E-03	1.32E-02
Mn-54	1.65E+00	4.61E+00
Nb-93m	4.01E+00	1.12E+01
Nb-94	6.89E-02	1.93E-01
Nb-95	2.07E-01	5.80E-01
Ni-59	1.03E+00	2.90E+00
Ni-63	9.93E+01	2.78E+02
Np-237	1.26E-08	3.54E-08
Pu-238	5.43E-02	1.52E-01
Pu-239	2.36E-03	6.61E-03
Pu-240	8.68E-05	2.43E-04
Pu-241	2.59E-02	7.25E-02
Pu-242	1.03E-06	2.90E-06
Pu-244	1.55E-13	4.34E-13
Sb-125	2.24E+00	6.28E+00
Se-79	5.17E-07	1.45E-06
Sn-126	1.55E-06	4.34E-06
Sr-90	9.47E-01	2.65E+00
Tc-99	1.42E-01	3.97E-01
Te-125m	5.18E-01	1.45E+00
Th-232	3.27E-10	9.17E-10
U-232	4.88E-06	1.37E-05
Zn-65	4.54E-01	1.27E+00
Zr-93	6.89E-04	1.93E-03
Zr-95	5.14E-01	1.44E+00

The dose consequence analysis is documented in ECAR-8154 (2024). The results show the potential dose consequences to the collocated worker and the public receptors from fire and drop accidents involving RWDS modules with extended service life are less than the bounding dose consequence evaluated in ECAR-1559, upon which facility safety controls were established. The safety basis bounds the potential accident dose consequences for the proposed service life extension of the NRF resins waste stream. Therefore, from the safety basis perspective, the RWDS resin modules with extended service life are acceptable for disposal at the RHLLW Disposal Facility.

Conclusions and Recommendations Regarding Potential Impacts to the Safety Basis

Based on the calculations and comparisons in this evaluation, the new canister-specific bounding RWDS module inventories based on service life extension are within the bounds of the safety basis.

The canister-specific bounding inventories in Table A-3 of ECAR-1559 should be updated with the values in this UDQE. After ECAR-1559 is updated, the canister-specific bounding inventories in Tables A-2 and A-4 of PLN-5446 should be updated.

References

DOE-ID. 2018. "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility." DOE/ID-11421 Revision 2, U.S. Department of Energy. Idaho Operations Office, February 2018.

ECAR-1559. 2020. "Evaluation of Facility Inventory and Radiological Consequences to Support RHLLW Disposal Facility Safety Basis." ECAR-1559 Revision 6, Idaho National Laboratory, Idaho Falls, ID.

ECAR-8154. 2024. "Dose Consequence Analysis for NRF Resins Service Life Extension." ECAR-8154 Revision 0, Idaho National Laboratory, Idaho Falls, ID.

NCRP. 1996. *Screening Models for Releases of Radionuclides to Atmospheric, Surface Water, and Ground - Worksheets*, NCRP Report No. 123 II (Vol. 2), National Council on Radiation Protection and Measurement.

Nelson, A.J. 2023. "NRF: Response to RHLLW questions regarding RWDS module service life extension." EDOC-NELSOAJ-2023-07-12 R1. Fluor Marine Propulsion, LLC, November 9, 2023.

PLN-5446. 2022. "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility." PLN-5446 Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Jonathan Jacobson	[signature] Jonathan Jacobson (Sep 25, 2024 07:09 MDT)	Sep 25, 2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
James Angell Neal E Russell	[signature] [signature] Neal Russell (Sep 30, 2024 07:30 MDT)	Sep 30, 2024 Sep 30, 2024
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	[signature] Jeff Sondrup (Sep 24, 2024 22:10 MDT)	Sep 24, 2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	[signature]	Sep 25, 2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	[signature] Timothy Arsenault (Sep 25, 2024 09:12 MDT)	Sep 25, 2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Neal

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ____________________

Special Analysis Document Number: ____________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ____________________

Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-080

Subject: Potential Impact of INTEC Calcined Solids Storage Facility PA and CA on the RHLLW Disposal Facility CA

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

During preparation of the RHLLW Disposal Facility CA (DOE/ID-11422, 2012), radioactive calcined waste stored in stainless-steel tanks (referred to as bins) at the Idaho Nuclear Technology and Engineering Center (INTEC) Calcined Solids Storage Facility (CSSF) was not considered a viable source for the RHLLW Disposal Facility CA because the information did not exist to develop a realistic and reliable source term.

The CSSF PA and CA were recently completed and approved by the DOE Low-Level Waste Disposal Facility Federal Review Group ("Performance Assessment and Composite Analysis for the INTEC Calcined Solids Storage Facility at the INL Site," DOE/ID-12008, 2022) documenting the impacts of residual radioactive calcined waste that may remain after the bulk of the waste is retrieved from the CSSF. Now that the CSSF PA and CA are complete and there is a realistic source term for consideration in other LLW disposal facility CAs, the CSSF CA was reviewed for potential impacts to the RHLLW CA.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments:

Since development of the RHLLW Disposal Facility CA in 2012, the RHLLW Disposal Facility was constructed and the PA updated (DOE/ID-11421, 2018) based on the as-built facility configuration and a 20-year operational period. A CA addendum (DOE/ID-11577, 2018) was also issued that incorporated the results of the updated PA. The CA addendum concluded the potential for the RHLLW Disposal Facility to impact groundwater pathway receptors[1] located downgradient or cross-gradient of the RHLLW Disposal Facility is negligible based on the facilities *de minimis* contribution to the cumulative groundwater dose at the facility's 100-m point of assessment.

Because operation of the RHLLW Disposal Facility will not impact decisions regarding the need for future remediation, even when considered cumulatively with other sources that can significantly interact with the RHLLW

[1] For the RHLLW Disposal Facility, the groundwater all-pathways dose is the all-pathways dose. Thus the RHLLW Disposal Facility CA only considered the groundwater pathway all-pathways dose.

Disposal Facility, potential impacts documented in the CSSF PA and CA have no bearing on the RHLLW Disposal Facility CA. Nevertheless, the CSSF PA and CA were reviewed in case the RHLLW Disposal Facility PA and CA were revisited.

A review determined the CSSF CA used results from the CSSF PA and cumulative peak doses from the Tank Farm Facility and INL CERCLA Disposal Facility (ICDF) CAs (both at INTEC) to support a similar conclusion that the CSSF dose contributions are insignificant and cannot have a significant impact on any other LLW disposal facilities or remediation decisions at the INL Site. Based on the conclusions that neither the RHLLW Disposal Facility, nor the CSSF closure configuration could reasonably produce a peak dose that would have a significant impact on another LLW disposal facility or remediation decision, there is no significant impact from the CSSF closure on the RHLLW Disposal Facility CA. Thus, unless there is a reevaluation of the CSSF PA, the CSSF source would be screened from the RHLLW Disposal Facility CA and no further evaluation is necessary.

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☒ Positive ☐

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☒ UDQE ☐ Special Analysis ☐

A. Jeff Sondrup	Jeff Sondrup	10/23/23
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	11/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☐

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☐

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☐

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☐

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☐

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-081

Subject: Canister ECF-05-18-118 from NRF flagged by RHINO during PA checks and WAC review

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-05-18-118 is a 55-Ton waste canister containing activated metals and surface contamination from Naval Reactors Facility (NRF). Prior to shipment, waste canisters details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-05-18-118 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventories of six radionuclides (Cm-245, Cm-246, Np-237, Pu-238, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for a specific generator (NRF), waste form (activated metals) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Four of the six radionuclides are non-key radionuclides and must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA.

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceeds the PA base-case inventory for this generator (NRF), waste form (activated metals) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
This check was flagged by RHINO because the canister inventory of six radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90 and U-234) exceed the 10% threshold levels of the base-case inventory analyzed in the PA for this generator, canister type and waste form (see INL/EXT-18-45184, Table 18). A threshold of 10% was selected by considering the total number of waste disposal vaults, the variance in expected container radionuclide inventory levels, and other pathway-specific considerations presented in INL/EXT-18-45184 (2018). According to INL/EXT-18-45184 (2018), if a single container exceeds 10% of the generator, waste form, and radionuclide-specific base-case inventory modeled in the PA, the container will be flagged for further review to determine if the canister inventory is an anomalous occurrence or indicative of a change in waste generation rates.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because unanalyzed radionuclides with half-lives greater than 1 year, and non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-05-18-118. These should be evaluated to confirm the inventories are within the bounds of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

In addition to the flagged checks by RHINO, the acceptance process revealed that Waste canister ECF-05-18-118 contains a small amount of Alconox, a dry-powder cleaning agent. The Alconox is packaged inside poly bottles that are inside a Compact Bale Container (CBC) that includes surface contaminated debris from NRF hot-cell operations.

The RHLLW Disposal Facility Waste Acceptance Criteria (WAC) PLN-5446 prohibits *"waste containing acids/bases or other chemicals (e.g., sodium, chloride) that would alter the pH and affect the corrosion rates of the canisters, liners, or reinforcement in the concrete vaults."* It is recommended the Alconox be evaluated to determine if it meets the RHLLW Disposal Facility Waste Acceptance Criteria (WAC) PLN-5446, and will not impact the conclusions of the PA.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-05-18-118 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the canister activities must be evaluated to confirm they are within the bounds of the approved PA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure*

approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☒ No ☐

Comments: Waste canister ECF-05-18-118 contains a small amount of Alconox, a dry-powder cleaning agent. It is recommended the Alconox be evaluated to determine if it meets the RHLLW Disposal Facility Waste Acceptance Criteria (WAC) PLN-5446, and will not impact the conclusions of the PA.

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	10/19/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	10/19/2023
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, 11 and 12 by RHINO during the acceptance check of waste canister ECF-05-18-118 and an evaluation of the physical inventory for acceptability according to the WAC.

Figure 1 shows the canisters details page from RHINO and the results of the PA check.

Canister Details ECF-05-18-118

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	10/11/2023
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	10/11/2023
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	10/11/2023
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	10/11/2023
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	10/11/2023
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	10/11/2023
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	10/11/2023
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	10/11/2023
5	Yes	Beta-Gamma ED	5.2809E-005	0.16	mrem/yr	Compliance	10/11/2023
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	10/11/2023
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	10/11/2023
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	10/11/2023
7	Yes	Intruder	1.3779E-001	20	mrem/yr	Compliance	10/11/2023
8	Yes	Air Pathway	7.3842E-005	0.4	mrem/yr	Compliance	10/11/2023
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	10/11/2023
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	10/11/2023
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	10/11/2023
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	10/11/2023
13	Yes	Canister Action Levels Check	-			Compliance	10/11/2023

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: NRF Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3196E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8283E-007	6.9997E-008	1.5921E-007
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1551E-007	3.5211E-008	6.5027E-008
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	4.7690E-008	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5364E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9718E-007	3.3543E-009	3.3745E-007
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.2768E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5296E-003	3.8088E-004	8.5672E-004
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5414E-011	3.0840E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.8443E-007	1.0867E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1467E-006	4.7761E-007	2.9011E-006
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6837E-006	5.3927E-009	9.5177E-007

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

11. Administrative 10% Canister Inventory Check (Canister Specific)

Nuclide	Form	Generator	Vault	Array	Amount (Ci)	PA Inv (Ci)	Threshold (Ci)
Cs-137	S	NRF	55-Ton Cask	3	2.7358E-002	6.9179E-002	6.9179E-003
Np-237	S	NRF	55-Ton Cask	3	3.3745E-007	3.3543E-009	3.3543E-010
Pu-239	S	NRF	55-Ton Cask	3	6.8433E-006	7.0409E-005	7.0409E-006
Pu-240	S	NRF	55-Ton Cask	3	1.7461E-006	6.2158E-005	6.2158E-006
Sr-90	S	NRF	55-Ton Cask	3	3.7170E-002	6.9832E-002	6.9832E-003
U-234	S	NRF	55-Ton Cask	3	2.9011E-006	4.7761E-007	4.7761E-008

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	5.3487E-007
Eu-154	S	NRF	3	3.1297E-004	8.5800E+000	1.6044E-004
Eu-155	S	NRF	3	8.8674E-005	4.7500E+000	4.5457E-005
H-3	S	NRF	3	7.2979E-006	1.2300E+001	3.7411E-006
Ra-228	S	NRF	3	3.7548E-013	5.7400E+000	1.9248E-013
Sm-147	S	NRF	3	3.3010E-015	1.0600E+011	1.6922E-015
Sm-151	S	NRF	3	7.3116E-005	9.0000E+001	3.7482E-005
Th-228	S	NRF	3	1.1157E-008	1.9100E+000	5.7193E-009
Th-229	S	NRF	3	1.1569E-012	7.8900E+003	5.9305E-013
Th-230	S	NRF	3	1.2567E-013	7.5400E+004	6.4425E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	4.2656E-024	S	Yes
Nd-144	2.0872E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-05-18-118.

PA Check 9

Canister ECF-05-18-118 contains six radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste forms (activated metals) (see Figure 1). Of the six radionuclides, four are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during preparation of the PA. The two key radionuclide (Np-237 and U-234) will be evaluated under PA Check 10 (see below).

The four non-key radionuclides (Cm-245, Cm-246, Pu-238, U-236) were screened out during the Phase II and III screenings during preparation of the PA. Table 1 shows that the new cumulative inventories would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percent of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-05-18-118) was added to the total PA base case inventory. This is conservative because the PA base case inventories include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form. The maximum allowable inventory allowed by the phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the cumulative inventory after placement of canister ECF-05-18-118 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-05-18-118 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-05-18-118 Inventory (Ci)[a]	Cumulative Inventory (Includes Placed Canisters + ECF-05-18-118) (Ci)[b]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[c]	Total PA Base Case Inventory + Cumulative Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[d]	Max Allowable Phase II Screening Inventory (Ci/yr)[e]	Total PA Base Case + Cumulative Inventory as % of Max Allowable Phase II Screening Inventory (Col 5/Col 7)
Cm-245	1.59E-07	2.82E-07	7.00E-08	3.52E-07	6.29E+04	6.36E-06	5.54%
Cm-246	2.50E-13	1.16E-07	3.52E-08	1.51E-07	3.00E+04	1.33E-05	1.13%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-05-18-118 Inventory (Ci)[a]	Cumulative Inventory (Includes Placed Canisters + ECF-05-18-118) (Ci)[b]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[c]	Total PA Base Case Inventory + Cumulative Inventory (Cols 3+4) (Ci)	PA Phase III Dose (mrem/yr)[f]	Max Allowable Phase III Screening Inventory (Ci/yr)[g]	Total PA Base Case + Cumulative Inventory as % of Max Allowable Phase III Screening Inventory (Col 5/Col 7)
Pu-238	8.57E-04	1.53E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	9.52E-07	1.68E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal with surface contamination in the proposed canister (see Figure 1).
b. Placed inventory includes canisters placed as of 10/10/2023 (see Figure 1).
c. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
d. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
e. $Imax_{II}$ from Equation 1 above.
f. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
g. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-05-18-118 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste forms (activated metals) (see Figure 1). These key radionuclide were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathways dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected dose impact from placement of the proposed canister. Table 2 shows the all-pathway dose impact before and after disposal of proposed canister ECF-05-18-118. The projected all-pathway dose after disposal of canister ECF-05-18-118 would increase less than 0.00000010% for the compliance period and 0.10% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-05-18-118 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-05-18-118 is within the bounds of the PA.

Table 2. All-pathway dose impact from placement of canister ECF-05-18-118.

1	2	3	4	5
Period	Current All-Pathways Dose from all Placed + Approved Canisters (mrem/yr)	All-Pathways Dose from ECF-05-18-118 (mrem/yr)	All-Pathways Dose After Placement of ECF-05-18-118 (mrem/yr) (Col 2 + Col 3)	% Increase in All-Pathways Dose After Placement of ECF-05-18-118
Compliance	1.35E-04	1.39E-13	1.35E-04	0.00000010%
Post-Compliance	7.88E-02	7.69E-05	7.89E-02	0.10%

PA Check 11

Figure 1 shows that PA Check 11 was flagged by RHINO because the surface contamination (SC) inventory of six radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90 and U-234) in waste canister ECF-05-18-118 exceeds 10% of the total base case inventory evaluated in the PA as SC in 55-Ton waste canisters from NRF. This check is only performed for key radionuclides. Np-237, Pu-239, Pu-240, and U-234 are key radionuclides in the PA for the groundwater pathway. Cs-137 and Sr-90 are key radionuclides for the intruder pathway. If the activity of a key radionuclide in a waste canister exceeds a 10% threshold activity level for that generator, canister type, and waste stream, the canister is flagged for further review according to the change control process to determine if the radionuclide inventory in the container being evaluated is an anomalous occurrence or indicative of a change in waste generation rates. The canister was also evaluated to determine if the inventories of the five radionuclides are within the bounds of the PA.

Table 3 shows the inventories of the radionuclides in canister ECF-05-18-118 that exceed the 10% criteria. Column 5 shows that while all exceed the 10% criteria, Np-237 and U-234 exceed the total PA base case inventory for this generator/canister/waste form (>100%). While this is high, Table 3 shows the inventories as a percentage of total 20-year base case inventory of SC for all generators are low (0.0 to 2.32%, see Column 9). Therefore, the inventory of the five radionuclides as SC in canister ECF-05-18-118 are within the bounds of the PA.

Table 3. Radionuclide inventories in canister ECF-05-18-118 that exceed the 10% criteria for SC in NRF 55-Ton canisters compared to PA 20-year base-case inventories of SC for all generators and canisters.

1	2	3	4	5	6	7
Nuclide	Waste Form[a]	Canister Inventory (Ci)	PA 20-yr Base Case Inventory for the Particular Waste Form in NRF 55-Ton Canisters (Ci)[b]	Can Inventory as % of PA 20-yr Base Case Inventory for the Particular Waste Form	PA 20-yr Base Case Inventory for RHLLW Facility and Particular Waste Form (Ci)[b]	Can Inventory as % of PA 20-yr Base Case Inventory RHLLW Facility and Particular Waste Form
Cs-137	SC	2.74E-02	6.92E-02	39.5%	9.18E+02	0.003%
Np-237	SC	3.37E-07	3.35E-09	10060%	5.82E-04	0.058%
Pu-239	SC	8.84E-06	7.04E-05	12.6%	3.15E-01	0.003%
Pu-240	SC	1.75E-05	6.22E-05	28.1%	2.28E-03	0.766%
Sr-90	SC	3.72E-02	6.98E-02	53%	6.42E+02	0.01%
U-234	SC	2.90E-06	4.78E-07	607%	1.25E-04	2.32%

a. SC = surface contamination
b. Radionuclide flagged by RHINO because percentage exceeds 10%

To determine if the inventories of the six key radionuclides are anomalous compared to other 55-Ton canisters, Table 4 compared the SC inventories in canister ECF-05-18-118 to the total SC inventories in the six 55-Ton canisters placed at the facility. The percentages in Column 5 (100% to 130%) indicate canister ECF-05-18-118 contains as much or more of the six radionuclides as SC as the six placed 55-Ton canisters. This is anomalous compared to the other 55-Ton canisters previously placed at the facility. However, much of the placed inventory comes from canister ECF-05-18-120. So the inventory of these radionuclides in canister ECF-05-18-118 is similar to ECF-05-18-120, and the inventories of both and unlike the other placed canisters. Because the number of cans placed in small (six), continued tracking is recommended to see if this continues to be the case.

Table 4. Radionuclide inventories in canister ECF-05-18-118 that exceed the 10% criteria for SC in NRF 55-Ton canisters compared to SC inventories in all previously placed 55-Ton canisters.

1	2	3	4	5
Nuclide	Waste Form[a]	Canister Inventory ECF-05-18-118 (Ci)	Inventory in Previously Placed NRF 55-Ton Canisters as SC (Ci)	Canister ECF-05-18-118 Inventory as % of Inventory in Previously Placed NRF 55-Ton Canisters as SC (Col 3/Col 4)
Cs-137	SC	2.74E-02	2.25E-02	122%
Np-237	SC	3.37E-07	2.60E-07	130%
Pu-239	SC	8.84E-06	8.83E-06	100%
Pu-240	SC	1.75E-05	1.46E-05	119%
Sr-90	SC	3.72E-02	3.00E-02	124%
U-234	SC	2.90E-06	2.25E-06	129%

a. SC = surface contamination

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-05-18-118 contains 10 unanalyzed radionuclides with half-lives greater than one year. These radionuclides for this generator (NRF), canister type (55-Ton) and waste forms were not reported in the PA base-case inventory and were not analyzed in the PA [see appropriate table in Appendix B of the WAC (PLN-5546) for list of analyzed radionuclides]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these 10 radionuclides when compared to the total canister inventory of 195 Ci are much less than 1% (see Figure 1). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium, however, is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 5 shows that all 10 radionuclides were reported in other generators waste (Column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (Column 2 ÷ Column 5). This confirms the unanalyzed radionuclides in canister ECF-05-18-118 will not impact the PA.

Table 5. Unanalyzed radionuclides in waste canister ECF-05-18-118 with half-lives greater than one year.

1	2	3	4	5	6
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory	Total PA Base Case Inventory All Waste Forms(Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)
Eu-152	1.04E-06	SC	5.35E-07%	4.14E+00	2.52E-05%
Eu-154	3.13E-04	SC	1.60E-04%	1.56E+01	2.01E-03%
Eu-155	8.87E-05	SC	4.55E-05%	1.65E+00	5.37E-03%
H-3	7.30E-05	SC	3.74E-05%	1.99E+03	3.67E-06%
Ra-228	3.75E-13	SC	1.92E-13%	2.28E-07	1.65E-04%
Sm-147	3.30E-15	SC	1.69E-15%	1.38E-10	2.39E-03%
Sm-151	7.31E-05	SC	3.75E-05%	5.27E+01	1.39E-04%
Th-228	1.12E-08	SC	5.72E-09%	2.02E-04	5.52E-03%
Th-229	1.16E-12	SC	5.93E-13%	5.35E-08	2.16E-03%
Th-230	1.26E-13	SC	6.44E-14%	4.93E-08	2.55E-04%

a. SC = surface contamination
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018), all waste forms.

Non-system Radionuclides

Figure 1 shows waste canister ECF-05-18-118 contains a non-system radionuclide Nd-144. Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Nd-144 was previously identified in other 55-Ton canisters from NRF. Table 6 shows Nd-144 is listed as both an activated metal (AM) waste form and SC waste form in canister ECF-05-18-118. Nd-144 is a non-system radionuclide because it has a very long half-life and may be considered observationally stable. The long half-life coupled with the very small inventories indicate Nd-144 will not have an impact on the PA.

Table 6. Non-system radionuclides in waste canister ECF-05-18-118.

Radionuclide	Canister Inventory (Ci)	Waste Form	Half-Life (yr)
Nd-144	4.27E-24	AM	2.29E+15
Nd-144	2.09E-23	SC	2.29E+15

Physical Inventory of ECF-05-18-118 (WAC Review)

Waste canister ECF-05-18-118 contains irradiated structural components, surface contaminated debris from the ECF water pool and surface contaminated debris from NRF hot-cell operations packaged inside a CBC identified as CBC 2040. CBCs are 12" x 20" x 18" stainless steel (304) containers with 3/16-inch-thick walls, a 1.25-inch-thick base, and lids of various thickness as required (See Figure 2 pictures of CBCs). CBC 2040 contains surface contaminated debris only. The CBC inventory indicated less than 250 ml Alconox powder (solid) packaged in 4 small poly bottles (1 bottle less 100 ml and 3 bottles less than 50 ml each).

Figure 2. Images of NRFs CBCs

The Material Safety Data Sheet (MSDS), Hazard Evaluation Form (HEF) and Deficiency Report (DR) were provided by NRF and reviewed by the Facility Disposition Specialist and discussed with the PA/CA Subject Matter Expert and a Chemical Engineer from MFC Environmental. The Alconox powder was evaluated against a list of prohibited items in Section 3.2 of the RHLLW WAC. Specifically, the facility will not accept

> *"...Waste containing acids/bases or other chemicals (e.g., sodium, chloride) that would alter the pH and affect the corrosion rates of the canisters, liners, or reinforcement in the concrete vaults."*

The Chemical Engineer conducted an evaluation to determine if the canister would be deemed acceptable for disposal with the small amounts of Alconox powder inside ECF-05-18-118. The evaluation determined the Alconox is not expected to affect the corrosion rates of the canisters, liners, or reinforcement in the concrete vaults because it is in solid form, sealed in poly bottles, and is unlikely to encounter water to form an aqueous solution. However, if water were to infiltrate the poly bottle and an aqueous solution form, the pH is not likely to be considered corrosive. The EPA classifies corrosive waste as an aqueous solution with a pH greater than or equal to 12.5, or less than or equal to 2. The technical data sheet provided by the manufacturer states that a 1% solution of Alconox has a pH of 9.5, which exhibits mild alkaline properties.

The MSDS also states that the product "contains an ingredient which may be corrosive." Therefore, each active ingredient in Alconox was evaluated to determine the corrosivity. Table 7 represents the active ingredients, associated C.A.S. Number, and concentrations contained in Alconox.

Table 7. Chemical constituents in Alconox.

C.A.S.	Concentration (%)	Ingredient Name
25155-30-0	10-30	Sodium Dodecylbenzenesulfonate
497-19-8	7-13	Sodium Carbonate
7722-88-5	10-30	Tetrasodium Pyrophosphate
7758-29-4	10-30	Sodium Phosphate

The major contributor to a higher pH in Alconox is sodium carbonate, which can exhibit a pH from 10 to 11. Since the concentration of sodium carbonate in Alconox is anywhere from 7 to 13, the pH is anticipated to be no more than 11, but likely smaller due to the lower concentration. Either way, the pH of 12.5 is not expected to be exceeded solely by Alconox alone. In addition, the Alconox powder contained in the poly bottles is less than 250 mL, which would not result in a significant corrosion rate to the canister, or overall vault array. According to the manufacturer's technical data sheets, Alconox is commonly used to clean stainless steel and is used as a corrosion inhibitor. In general, there is no grade of stainless steel that is attacked during the cleaning process with Alconox detergent. The pH of the waste is not expected to be altered from the containment of Alconox and the corrosion rates of the canisters, liners, or reinforcement in the concrete vaults are not expected to be affected.

Sodium carbonate is also known to cause concrete deteriorations from salt crystallization. However, because there is only 7-13% sodium carbonate with a total volume of 250 mL of Alconox, it is unlikely that it will have a detrimental effect on concrete. The density of Alconox detergent varies from 0.85 g/mL to 1.1 g/mL, with a typical density of 0.95 g/mL. Using a density of 0.95 g/mL and a total maximum volume of 250 mL for Alconox, and assuming it contains 13% sodium carbonate, this would result in 30.9 g (0.068 lb) of sodium carbonate. This small amount of sodium carbonate will not contribute to an increase in composition of infiltrating water at the INL Site (see INL 2011, Table 2) and will not impact the integrity of the concrete vault that it's in, or any surrounding vaults.

Based on the evaluation, the Alconox is acceptable according to requirements in Section 3.2 of PLN-5446, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility:"

Summary

The radionuclide inventory of waste canister ECF-05-18-118 has been evaluated with respect to potential impacts on the PA and WAC requirements. Based on the evaluation, impacts to the PA are small and within the bounds of the PA and the contents meet acceptability requirements of the WAC. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

INL, 2011, *Assessment of Geochemical Environment for the Proposed INL Remote-Handled Low-Level Waste Disposal Facility,* INL/EXT-10-19385, Idaho National Laboratory.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	10/19/2023
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	10/19/23
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	10/19/2023
Paul A. Velasquez Waste Management/WMP	Paul Velasquez Waste Management/WMP	10/19/2023
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	10/19/2023

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ____________________

Special Analysis Document Number: ____________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ____________________

Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-082

Subject: Canister ECF-01-21-114 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-114 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canisters details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-114 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventories of six radionuclides (Cm-245, Cm-246, Np-237, Pu-238, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for a specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Four of the six radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The four non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
PA check 11 was flagged by RHINO as failed, but no key radionuclides were identified by RHINO as having exceeded the 10% canister inventory threshold. Therefore, the inventory of each key radionuclide in canister ECF-01-21-114 in both activated metal and surface contamination waste form was compared to the 10% threshold values in INL (2018). The inventories were all less than the 10% threshold values indicating the check should have passed and does not need further evaluation. RHINO will be investigated to determine why this check was incorrectly flagged.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
PA check 12 was flagged by RHINO because nine unanalyzed radionuclides with half-lives greater than 1 year, and one non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-01-21-114. These must be evaluated to confirm the inventories are within the bounds of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-114 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the canister activities must be evaluated to confirm they are within the bounds of the approved PA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in*

the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	*Jonathan Jacobson*	11/1/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Timothy Arsenault*	11/1/2023
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

   Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

   Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

   Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

   Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-114. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-114

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	10/30/2023
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	10/30/2023
2	Yes	Beta-Gamma DE	9.8157E-006	0.15	mrem/yr	Compliance	10/30/2023
	Yes	Beta-Gamma DE	5.5966E-002	2.4	mrem/yr	Post Compliance	10/30/2023
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	10/30/2023
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	10/30/2023
4	Yes	Gross Alpha	4.5198E-030	0.5	pCi/L	Compliance	10/30/2023
	Yes	Gross Alpha	8.3351E-006	7.5	pCi/L	Post Compliance	10/30/2023
5	Yes	Beta-Gamma ED	5.2809E-006	0.15	mrem/yr	Compliance	10/30/2023
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	10/30/2023
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	10/30/2023
	Yes	Uranium	1.8714E-006	15	ug/L	Post Compliance	10/30/2023
7	Yes	Intruder	1.3919E-001	20	mrem/yr	Compliance	10/30/2023
8	Yes	Air Pathway	8.3193E-006	0.4	mrem/yr	Compliance	10/30/2023
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	10/30/2023
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	10/30/2023
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	10/30/2023
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	10/30/2023
13	Yes	Canister Action Levels Check	-			Compliance	10/30/2023

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold.

Generator Facility: NRF
Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8302E-007	5.9997E-008	1.9882E-010
Cm-246 [Details]	4.7600E+003	S	55-Ton Cask	NRF	3	West	1.1659E-007	3.6211E-008	7.9496E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	4.7690E-005	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5364E-007	1.5460E-007	
Np-237 [Details]	2.1600E+006	S	55-Ton Cask	NRF	3	West	5.9721E-007	3.3543E-009	2.9494E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.2768E-005	8.0363E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5327E-003	3.8088E-004	3.0321E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5414E-011	3.0840E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0045E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.5443E-007	1.0867E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	
U-234 [Details]	2.4500E+005	S	55-Ton Cask	NRF	3	West	5.1491E-005	4.7761E-007	2.4042E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6837E-005	5.3927E-009	8.7372E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	5.5154E-007
Eu-154	S	NRF	3	3.0661E-006	8.5900E+000	1.6208E-006
Eu-155	S	NRF	3	8.3128E-007	4.7500E+000	4.3943E-007
H-3	S	NRF	3	3.3567E-006	1.2300E+001	1.7744E-006
Ra-228	S	NRF	3	4.0008E-013	5.7400E+000	2.1149E-013
Sm-147	S	NRF	3	3.4289E-018	1.0600E+011	1.8126E-018
Th-228	S	NRF	3	1.1095E-008	1.9100E+000	5.8648E-009
Th-229	S	NRF	3	1.2697E-012	7.8900E+003	6.7120E-013
Th-230	S	NRF	3	1.3794E-013	7.5400E+004	7.2917E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	4.2855E-024	S	Yes
Nd-144	2.0872E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-114.

PA Check 9

Waste canister ECF-01-21-114 contains six radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the six radionuclides, four (Cm-245, Cm-246, Pu-238, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-114 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

The four non-key radionuclides (Cm-245, Cm-246, Pu-238, U-236) were screened out during the Phase II and III screenings during preparation of the PA. Table 1 shows that the new cumulative inventories would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-114) was added to the total PA base case inventory. This is conservative because the PA base case inventories include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-114 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each radionuclide, the totals (column 5) are fractions of the maximum allowable phase II and phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-01-21-114 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-114 Inventory (Ci)[a]	Cumulative Inventory (Includes Placed Canisters + ECF-01-21-114) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Total PA Base Case Inventory + Cumulative Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	Total PA Base Case + Cumulative Inventory as % of Max Allowable Phase II Screening Inventory (Col 5/Col 7)
Cm-245	1.99E-10	2.83E-07	5.28E-07	8.11E-07	6.29E+04	6.36E-06	12.8%
Cm-246	7.95E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-01-21-114 Inventory (Ci)[a]	Cumulative Inventory (Includes Placed Canisters + ECF-01-21-114) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Total PA Base Case Inventory + Cumulative Inventory (Cols 3+4) (Ci)	PA Phase III Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	Total PA Base Case + Cumulative Inventory as % of Max Allowable Phase II Screening Inventory (Col 5/Col 7)
Pu-238	3.03E-06	1.53E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	8.74E-12	1.68E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{III}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-01-21-114 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canisters) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-114. The projected all-pathway dose after disposal of canister ECF-01-21-114 would increase less than 0.01% for the compliance period and 0.10% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-114 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 12.7%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-114 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-114.

1	2	3	4	5	6	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Placed Canisters	Proposed Canister ECF-01-21-114	Placed Canisters + Proposed Canister ECF-01-21-114 (Col 6 + Col 7)	Percent Increase in Performance Measure from Placement of Canister ECF-01-21-114 (Col 7/Col 6)
All Pathways Dose	Compliance	mrem/yr	1	25	1.3538E-04	8.1438E-13	1.3538E-04	<0.01%
All Pathways Dose	Post Compliance	mrem/yr	12.5	25	7.8835E-02	7.7019E-05	7.8912E-02	0.10%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	9.6157E-05	5.7820E-13	9.6157E-05	<0.01%
Beta-Gamma DE	Post Compliance	mrem/yr	2.4	4	5.5965E-02	2.7612E-05	5.5992E-02	0.05%
Ra-226/228 Conc	Compliance	pCi/L	0.2	5	2.1749E-32	1.1016E-41	2.1749E-32	<0.01%
Ra-226/228 Conc	Post Compliance	pCi/L	2.5	5	2.0304E-06	9.9448E-11	2.0305E-06	<0.01%
Gross Alpha Conc	Compliance	pCi/L	0.6	15	4.5198E-30	1.8555E-37	4.5198E-30	<0.01%
Gross Alpha Conc	Post Compliance	pCi/L	7.5	15	6.3351E-06	2.4770E-10	6.3353E-06	<0.01%
Beta-Gamma EDE	Compliance	mrem/yr	0.16	4	5.2609E-05	3.1634E-13	5.2609E-05	<0.01%
Beta-Gamma EDe	Post Compliance	mrem/yr	2	4	3.0619E-02	2.2446E-05	3.0642E-02	0.07%
Uranium Conc	Compliance	ug/L	1.2	30	8.7798E-28	1.6640E-34	8.7798E-28	<0.01%
Uranium Conc	Post Compliance	ug/L	15	30	1.6714E-05	2.3865E-08	1.6738E-05	0.14%
Intruder Dose	Compliance	mrem/yr	20	100	1.3779E-01	1.3970E-03	1.3919E-01	1.01%
Air Pathway Dose	Compliance	mrem/yr	0.4	10	7.3842E-05	9.3513E-06	8.3193E-05	12.7%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-114 contains 9 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory and were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these 9 radionuclides when compared to the total canister inventory (189 Ci) are much less than 1% (see Figure 1). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium, however, is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 2 shows that all nine radionuclides were reported in other generators waste (Column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are small fractions of the total PA base-case inventory (Column 2 ÷ Column 5). This confirms that the unanalyzed radionuclides in canister ECF-01-21-114 will not impact the PA.

Table 2. Unanalyzed radionuclides in waste canister ECF-01-21-114 with half-lives greater than one year.

1	2	3	4	5	6
Radionuclide	Canister Inventory (Ci)	Waste Form	Radionuclide Inventory as % of Total Canister Inventory	Total PA Base Case Inventory All Waste Forms(Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)
Eu-152	1.0434E-06	SC	5.52E-07%	4.14E+00	2.52E-05%
Eu-154	3.0661E-06	SC	1.62E-06%	1.56E+01	1.97E-05%
Eu-155	8.3128E-07	SC	4.39E-07%	1.65E+00	5.04E-05%
H-3	3.3567E-06	SC	1.77E-06%	1.99E+03	1.69E-07%
Ra-228	4.0008E-13	SC	2.11E-13%	2.28E-07	1.75E-04%
Sm-147	3.4289E-15	SC	1.81E-15%	1.38E-10	2.48E-03%
Th-228	1.1095E-08	SC	5.86E-09%	2.02E-04	5.49E-03%
Th-229	1.2697E-12	SC	6.71E-13%	5.35E-08	2.37E-03%
Th-230	1.3794E-13	SC	7.29E-14%	4.93E-08	2.80E-04%

a. SC = surface contamination

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-114 contains one non-system radionuclide (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 3 shows radionuclide Nd-144 is listed as both an activated metal waste form (AM) and surface contamination waste form (SC). Nd-144 is a non-system radionuclide because it has a very long half-life and may be considered observationally stable. The long half-life coupled with the very small inventories indicate Nd-144 will not have an impact on the PA.

Table 3. Non-system radionuclides in waste canister ECF-01-21-114.

Radionuclide	Canister Inventory (Ci)	Waste Form	Half-Life (yr)
Nd-144	2.09E-23	AM	2.29E+15
Nd-144	4.27E-24	SC	2.29E+15

Summary

The radionuclide inventory of waste canister ECF-01-21-114 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	11/1/2023 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	11/1/23 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	11/1/2023 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul Velasquez Signature Waste Management/WMP	11/01/2023 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	11/1/2023 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-083

Subject: Canister ECF-05-18-113 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-05-18-113 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-05-18-113 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventory of 15 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Thirteen of the 15 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because ten unanalyzed radionuclides with half-lives greater than 1 year, and two non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-05-18-113. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

   Yes ☒ No ☐

Comments: Canister ECF-05-18-113 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

   Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	11/14/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	11/15/2023
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-05-18-113. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-05-18-113

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3638E-004	1	mrem/yr	Compliance	11/8/2023
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	11/8/2023
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	11/8/2023
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	11/8/2023
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	11/8/2023
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	11/8/2023
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	11/8/2023
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	11/8/2023
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	11/8/2023
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	11/8/2023
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	11/8/2023
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	11/8/2023
7	Yes	Intruder	1.3993E-001	20	mrem/yr	Compliance	11/8/2023
8	Yes	Air Pathway	8.9846E-005	0.4	mrem/yr	Compliance	11/8/2023
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	11/8/2023
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	11/8/2023
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	11/8/2023
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	11/8/2023
13	Yes	Canister Action Levels Check	-			Compliance	11/8/2023

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold

Generator Facility: NRF   Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	1.3933E-013
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	8.3136E-015
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8317E-007	6.9987E-008	1.4146E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1564E-007	3.5211E-008	5.6605E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	4.7600E-006	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	2.1231E-011
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5365E-007	1.5450E-007	1.0518E-011
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9723E-007	3.3543E-009	2.0588E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5713E-005	8.0353E-005	2.9456E-006
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5346E-003	5.8088E-004	1.9560E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5414E-011	3.0840E-012	1.2256E-017
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	6.7896E-014
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	
Th-229 [Details]	7.8800E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	7.1277E-014
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	1.4115E-013
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1508E-006	4.7761E-007	1.7068E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6837E-006	5.3927E-009	6.2096E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Cd-113	A	NRF	3	2.0000E-028	7.7000E+015	1.1102E-028
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	5.7917E-007
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	6.8956E-007
Gd-152	A	NRF	3	1.5079E-021	1.0800E+014	8.3701E-022
H-3	S	NRF	3	1.3676E-006	1.2300E+001	7.5915E-007
Ra-228	S	NRF	3	2.6392E-013	5.7400E+000	1.4650E-013
Sm-147	S	NRF	3	2.3309E-015	1.0600E+011	1.2938E-015
Th-228	S	NRF	3	7.9544E-009	1.9100E+000	4.4154E-009
Th-229	S	NRF	3	8.0657E-013	7.8900E+003	4.4883E-013
Th-230	S	NRF	3	8.7754E-014	7.5400E+004	4.8711E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	3.0328E-024	S	Yes
Nd-144	1.6682E-023	A	Yes
Sm-148	3.0829E-025	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-05-18-113.

PA Check 9

Waste canister ECF-05-18-113 contains 15 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 15 radionuclides, 13 (Ac-227, Ce-142, Cm-245, Cm-246, Ir-192m, Ir-192m, Pt-193, Pu-238, Ra-226, Ra-228, Th-229, Th-232, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-05-18-113 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Of the 13 non-key radionuclides that were screened out during the PA screening process, one (Ce-142) was screened during Phase I because it is observationally stable. The other 12 were screened out during the Phase II and III screenings. Table 1 shows that the new cumulative inventories of the 12 radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-05-18-113 was added to the total PA base case inventory. This is conservative because the PA base case inventories include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-05-18-113 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each radionuclide, the totals (column 5) are fractions of the maximum allowable phase II and phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-05-18-113 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-05-18-113 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-05-18-113) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-05-18-113 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-05-18-113 as % of Max Allowable Phase II Screening Inventory
Cm-245	1.4146E-10	2.8317E-07	5.28E-07	8.11E-07	6.29E+04	6.36E-06	12.8%[g]
Cm-246	5.6603E-11	1.1564E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.50%
La-137	1.0518E-11	4.5365E-07	2.38E-06	2.83E-06	9.62E+02	4.16E-04	0.68%
Pt-193	2.9450E-06	9.5713E-05	6.64E-04	7.60E-04	2.92E+02	1.37E-03	55.5%[g]
Ra-226	1.2250E-17	5.5414E-11	3.14E-11	8.68E-11	2.96E+05	1.35E-06	0.006%
Ra-228	6.7896E-14	3.0046E-08	2.28E-07	2.58E-07	1.11E+05	3.60E-06	7.16%
Th-229	7.1277E-14	2.8398E-08	5.35E-08	8.19E-08	1.18E+05	3.38E-06	2.42%
Th-232	1.4115E-13	3.0129E-08	2.48E-07	2.78E-07	3.66E+05	1.09E-06	25.5%[g]
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-05-18-113 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-05-18-113) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-05-18-113 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-05-18-113 as % of Max Allowable Phase III Screening Inventory
Ac-227	1.3933E-13	2.9789E-07	5.76E-06	6.06E-06	<1E-40	2.30E+34	2.63E-38%
Ir-192m	2.1231E-11	1.7566E-06	1.07E-05	1.25E-05	<1E-40	4.28E+34	2.91E-38%
Pu-238	1.9560E-06	1.5346E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	6.2096E-12	1.6837E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.
g. Exceeds 10% of the maximum allowable Phase II screening inventory. If this had exceeded 100%, the inventory would be evaluated using the Phase III criteria.

PA Check 10

Canister ECF-05-18-113 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canisters) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-05-18-113. The projected all-pathway dose after disposal of canister ECF-05-18-113 would increase by 0.00000005% for the compliance period and 0.07% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-05-18-113 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 8.0%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-05-18-113 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-05-18-113.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-05-18-113	Placed Canisters + Proposed Canister ECF-05-18-113	Percent Increase in Performance Measure from Placement of Canister ECF-05-18-113 (Col 7/Col 6)
All Pathways Dose	Compliance	mrem/yr	1	25	6.579E-14	1.354E-04	0.00000005%
All Pathways Dose	Post Compliance	mrem/yr	12.5	25	5.516E-05	7.884E-02	0.07%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	4.671E-14	9.616E-05	0.00000005%
Beta-Gamma DE	Post Compliance	mrem/yr	2.4	4	1.894E-05	5.597E-02	0.03%
Ra-226/228 Conc	Compliance	pCi/L	0.2	5	9.314E-42	2.175E-32	0.00000004%
Ra-226/228 Conc	Post Compliance	pCi/L	2.5	5	1.178E-10	2.030E-06	0.01%
Gross Alpha Conc	Compliance	pCi/L	0.6	15	1.256E-37	4.520E-30	0.000003%
Gross Alpha Conc	Post Compliance	pCi/L	7.5	15	2.588E-10	6.335E-06	0.004%
Beta-Gamma EDE	Compliance	mrem/yr	0.16	4	2.556E-14	5.261E-05	0.00000005%
Beta-Gamma EDe	Post Compliance	mrem/yr	2	4	1.606E-05	3.062E-02	0.05%
Uranium Conc	Compliance	ug/L	1.2	30	1.142E-34	8.780E-28	0.00001%
Uranium Conc	Post Compliance	ug/L	15	30	2.900E-08	1.671E-05	0.17%
Intruder Dose	Compliance	mrem/yr	20	100	7.402E-04	1.399E-01	0.53%
Air Pathway Dose	Compliance	mrem/yr	0.4	10	6.652E-06	8.985E-05	8.0%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-05-18-113 contains ten unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (activated metal) were not reported in the PA base-case inventory and were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these ten radionuclides when compared to the total canister inventory (180 Ci) are much less than 1% (see Figure 1). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium, however, is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 2 shows that eight of the ten radionuclides were reported in other waste streams (Column 5). The two radionuclides not reported in other waste streams (Cd-113 and Gd-152), were likely not reported because the half-lives are extremely long (8.0E+15 yrs and 1.1E+14 yrs respectively). Column 6 shows the canister inventories of the other unanalyzed radionuclides are small fractions of the total PA base-case inventory (Column 2 ÷ Column 5). This confirms that the unanalyzed radionuclides in canister ECF-05-18-113 will not impact the PA.

Table 2. Unanalyzed radionuclides in waste canister ECF-05-18-113 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Cd-113	2.0000E-28	AM	1.11E-28%	NA	NA	NA
Eu-152	2.1226E-07	AM	1.18E-07%	4.14E+00	5.13E-06%	III
Eu-154	4.6318E-07	AM	2.57E-07%	1.56E+01	2.97E-06%	III
Gd-152	1.5079E-21	AM	8.37E-22%	NA	NA	NA
H-3	4.9133E-02	AM	2.73E-02%	1.99E+03	2.47E-03%	Retained
Ra-228	6.7896E-14	AM	3.77E-14%	2.28E-07	2.98E-05%	II
Sm-147	1.7597E-16	AM	9.77E-17%	1.38E-10	1.28E-04%	II
Th-228	1.5418E-10	AM	8.56E-11%	2.02E-04	7.63E-05%	III
Th-229	7.1277E-14	AM	3.96E-14%	5.35E-08	1.33E-04%	II
Th-230	6.5111E-12	AM	3.61E-12%	4.93E-08	1.32E-02%	II

a. AM = Activated Metal, SC = surface contamination
NA = Not Applicable. Not included in any base case PA waste streams.

Non-system Radionuclides

Figure 1 shows waste canister ECF-05-18-113 contains two non-system radionuclides (Nd-144 and Sm-148). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 3 shows radionuclide Nd-144 is listed as both an activated metal waste form (AM) and surface contamination waste form (SC). Nd-144 and Sm-148 are non-system radionuclides because they have very long half-lives. The long half-lives coupled with the very small inventories indicate Nd-144 and Sm-148 will not have an impact on the PA.

Table 3. Non-system radionuclides in waste canister ECF-05-18-113.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nd-144	3.03E-24	SC	2.3E+15
Nd-144	1.66E-23	AM	2.3E+15
Sm-148	3.08E-23	AM	6.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-05-18-113 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Jonathan Jacobson	Jonathan Jacobson	11/15/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	11/14/23
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	11/14/2023
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	11/14/2023
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	11/15/2023
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-084

Subject: Canister ECF-05-18-105 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-05-18-105 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-05-18-105 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)

PA check 9 was flagged by RHINO because the cumulative inventory of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)

PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check

This flag was checked by RHINO because nine unanalyzed radionuclides with half-lives greater than 1 year, and one non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-05-18-105. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-05-18-105 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	*Jonathan Jacobson*	12/6/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Timothy Arsenault*	12/6/23
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-05-18-105. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-05-18-105

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	12/4/2023
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	12/4/2023
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	12/4/2023
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	12/4/2023
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	12/4/2023
	Yes	Ra-226/228	2.0004E-006	2.5	pCi/L	Post Compliance	12/4/2023
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	12/4/2023
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	12/4/2023
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	12/4/2023
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	12/4/2023
6	Yes	Uranium	8.7758E-028	1.2	ug/L	Compliance	12/4/2023
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	12/4/2023
7	Yes	Intruder	1.4066E-001	20	mrem/yr	Compliance	12/4/2023
8	Yes	Air Pathway	9.7073E-005	0.4	mrem/yr	Compliance	12/4/2023
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	12/4/2023
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	12/4/2023
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	12/4/2023
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	12/4/2023
13	Yes	Canister Action Levels Check	-			Compliance	12/4/2023

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**

Generator Facility: NRF | Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8332E-007	6.9997E-008	1.5364E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1570E-007	3.5211E-008	6.1453E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	4.7690E-006	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5965E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9725E-007	3.3543E-009	2.2816E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5713E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5370E-003	3.8088E-004	2.3877E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5414E-011	3.0840E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1526E-006	4.7761E-007	1.8565E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6837E-006	5.3927E-009	6.7468E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	8.2878E-007
Eu-154	S	NRF	3	2.3512E-006	8.5900E+000	1.8676E-006
Eu-155	S	NRF	3	5.0545E-007	4.7500E+000	4.0149E-007
H-3	S	NRF	3	2.5771E-006	1.2300E+001	2.0470E-006
Ra-228	S	NRF	3	3.0968E-013	5.7400E+000	2.4598E-013
Sm-147	S	NRF	3	2.6522E-015	1.0600E+011	2.1067E-015
Th-228	S	NRF	3	8.5769E-009	1.9100E+000	6.8128E-009
Th-229	S	NRF	3	9.8316E-013	7.8900E+003	7.8094E-013
Th-230	S	NRF	3	1.0577E-013	7.5400E+004	8.4808E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	3.2937E-024	S	Yes
Nd-144	1.6869E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-05-18-105.

PA Check 9

Waste canister ECF-05-18-105 contains 17 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 17 radionuclides, 15 (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-05-18-105 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-05-18-105 contains four non-key radionuclides that exceed the PA base case inventory: Cm-245, and Cm-246 (screened during Phase II), and Pu-238 and U-236 (screened during Phase III). Table 1 shows that the new cumulative inventories of the 4 non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-05-18-105) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x\ \frac{I_{PAi}\ (Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-05-18-105 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-05-18-105 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-05-18-105 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-05-18-105) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-05-18-105 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-05-18-105 as % of Max Allowable Phase II Screening Inventory
Cm-245	1.5364E-10	2.8332E-07	5.28E-07	8.11E-07	6.29E+04	6.36E-06	12.8%
Cm-246	6.1453E-11	1.1570E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.50%
Radionuclides Screened During PA Phase III Screening							
Key Radionuclide	ECF-05-18-105 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-05-18-105) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-05-18-105 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-05-18-105 as % of Max Allowable Phase III Screening Inventory
Pu-238	2.3877E-06	1.5370E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	6.7468E-12	1.6837E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-05-18-105 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-05-18-105. The projected all-pathway dose after disposal of canister ECF-05-18-105 would increase by 0.0000004% for the compliance period and 0.08% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-05-18-105 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 8.0%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-05-18-105 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-05-18-105.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-05-18-105 (mrem/yr)	Placed Canisters + Proposed Canister ECF-05-18-105 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-05-18-105
All Pathways Dose	Compliance	mrem/yr	1	25	5.126E-13	1.354E-04	0.0000004%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	5.953E-05	7.884E-02	0.08%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	3.639E-13	9.616E-05	0.0000004%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	2.043E-05	5.597E-02	0.04%
Ra-226/228	Compliance	pCi/L	0.2	5	9.252E-42	2.175E-32	0.00000004%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.002E-10	2.030E-06	0.005%
Gross Alpha	Compliance	pCi/L	0.6	15	1.401E-37	4.520E-30	0.000003%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	2.230E-10	6.335E-06	0.004%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	1.991E-13	5.261E-05	0.0000004%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.735E-05	3.062E-02	0.06%
Uranium	Compliance	ug/L	1.2	30	1.264E-34	8.780E-28	0.00001%
Uranium	Post-Compliance	ug/L	15	30	2.444E-08	1.671E-05	0.15%
Intruder	Compliance	mrem/yr	20	100	9.319E-04	1.409E-01	0.67%
Air Pathway	Compliance	mrem/yr	0.4	10	7.228E-06	9.707E-05	8.04%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-05-18-105 contains nine unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these nine radionuclides when compared to the total canister inventory (126 Ci) are much less than 1% (see Table 3, column 4). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 3 shows that all nine radionuclides were reported in other waste streams (column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (column 2 ÷ column 5). This confirms that the unanalyzed radionuclides in canister ECF-05-18-105 will not impact the PA.

Table 3. Unanalyzed radionuclides in waste canister ECF-05-18-105 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Eu-152	1.0434E-06	SC	8.29E-07%	4.14E+00	2.52E-05%	III
Eu-154	2.3512E-06	SC	1.87E-06%	1.56E+01	1.51E-05%	III
Eu-155	5.0545E-07	SC	4.01E-07%	1.65E+00	3.06E-05%	III
H-3	2.5771E-06	SC	2.05E-06%	1.99E+03	1.30E-07%	Retained
Ra-228	3.0968E-13	SC	2.46E-13%	2.28E-07	1.36E-04%	II

Sm-147	2.6522E-15	SC	2.11E-15%	1.38E-10	1.92E-03%	II
Th-228	8.5769E-09	SC	6.81E-09%	2.02E-04	4.25E-03%	III
Th-229	9.8316E-13	SC	7.81E-13%	5.35E-08	1.84E-03%	II
Th-230	1.0677E-13	SC	8.48E-14%	4.93E-08	2.17E-04%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 126 Ci (from RHINO).
NA = Not Applicable. Not included in any base case PA waste streams.

Non-system Radionuclides
Figure 1 shows waste canister ECF-05-18-105 contains one non-system radionuclide (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 4 shows radionuclide Nd-144 is listed as both an activated metal (AM) waste form and surface contamination (SC) in canister ECF-05-18-105. Nd-144 is a non-system radionuclide because of its very long half-life. The long half-life coupled with the very small inventories (< 1E-22 Ci) indicate Nd-144 will not have an impact on the PA.

Table 4. Non-system radionuclides in waste canister ECF-05-18-105.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nd-144	3.29E-24	SC	2.3E+15
Nd-144	1.69E-23	AM	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-05-18-105 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Jonathan Jacobson	Jonathan Jacobson	12/6/2023
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	12/5/23
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	12/06/2023
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	12/06/2023
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	12/6/23
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-085

Subject: Canister ECF-01-21-105 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-105 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-105 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventory of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because nine unanalyzed radionuclides with half-lives greater than 1 year, and one non-system/non-exempt radionuclide were identified by RHINO in waste canister ECF-01-21-105. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-105 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Kira Overin	*Kira Overin*	1/10/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Timothy Arsenault*	1/10/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-105. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-105

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	1/3/2024
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	1/3/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	1/3/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	1/3/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	1/3/2024
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	1/3/2024
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	1/3/2024
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	1/3/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	1/3/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	1/3/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	1/3/2024
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	1/3/2024
7	Yes	Intruder	1.4203E-001	20	mrem/yr	Compliance	1/3/2024
8	Yes	Air Pathway	1.0537E-004	0.4	mrem/yr	Compliance	1/3/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	1/3/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	1/3/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	1/3/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	1/3/2024
13	Yes	Canister Action Levels Check	-			Compliance	1/3/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**

Generator Facility: NRF   Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8350E-007	6.9997E-008	1.7624E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1578E-007	3.5211E-008	7.0478E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	4.7690E-006	4.0123E-006	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5365E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9728E-007	3.3543E-009	2.5922E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5713E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5398E-003	3.6088E-004	2.8283E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5414E-011	3.0640E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5522E-008	
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1548E-006	4.7761E-007	2.1289E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6837E-006	5.3927E-009	7.7404E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	6.4941E-007
Eu-154	S	NRF	3	3.1018E-006	8.5900E+000	1.9306E-006
Eu-155	S	NRF	3	8.4755E-007	4.7500E+000	5.2752E-007
H-3	S	NRF	3	3.3957E-006	1.2300E+001	2.1135E-006
Ra-228	S	NRF	3	3.4354E-013	5.7400E+000	2.1382E-013
Sm-147	S	NRF	3	2.9822E-015	1.0600E+011	1.8562E-015
Th-228	S	NRF	3	9.8646E-009	1.9100E+000	6.1399E-009
Th-229	S	NRF	3	1.0740E-012	7.8900E+003	6.6846E-013
Th-230	S	NRF	3	1.1665E-013	7.5400E+004	7.2606E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	3.7795E-024	S	Yes
Nd-144	1.8870E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-105.

PA Check 9

Waste canister ECF-01-21-105 contains 17 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 17 radionuclides, 15 (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-105 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-01-21-105 contains four non-key radionuclides that exceed the PA base case inventory: Cm-245, and Cm-246 (screened during Phase II), and Pu-238 and U-236 (screened during Phase III). Table 1 shows that the new cumulative inventories of the 4 non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-105) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PAi}\,(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-105 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-01-21-105 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-105 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-105) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-105 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-105 as % of Max Allowable Phase II Screening Inventory
Cm-245	1.7624E-10	2.8350E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	7.0478E-11	1.1578E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.50%
Radionuclides Screened During PA Phase III Screening							
Key Radionuclide	ECF-01-21-105 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-105) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-105 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-105 as % of Max Allowable Phase III Screening Inventory
Pu-238	2.8283E-06	1.5398E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	7.7404E-12	1.6837E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-01-21-105 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-105. The projected all-pathway dose after disposal of canister ECF-01-21-105 would increase by 0.0000006% for the compliance period and 0.09% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-105 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 8.5%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-105 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-105.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-105 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-105 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-105
All Pathways Dose	Compliance	mrem/yr	1	25	8.203E-13	1.354E-04	0.0000006%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	6.831E-05	7.884E-02	0.09%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	5.824E-13	9.616E-05	0.0000006%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	2.756E-05	5.597E-02	0.05%
Ra-226/228	Compliance	pCi/L	0.2	5	1.013E-41	2.175E-32	0.00000005%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	9.973E-11	2.030E-06	0.005%
Gross Alpha	Compliance	pCi/L	0.6	15	1.628E-37	4.520E-30	0.000004%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	2.348E-10	6.335E-06	0.004%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	3.186E-13	5.261E-05	0.0000006%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.991E-05	3.062E-02	0.07%
Uranium	Compliance	ug/L	1.2	30	1.464E-34	8.780E-28	0.00002%
Uranium	Post-Compliance	ug/L	15	30	2.415E-08	1.671E-05	0.14%
Intruder	Compliance	mrem/yr	20	100	1.167E-03	1.420E-01	0.83%
Air Pathway	Compliance	mrem/yr	0.4	10	8.294E-06	1.054E-04	8.54%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-105 contains nine unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these nine radionuclides when compared to the total canister inventory (161 Ci) are much less than 1% (see Table 3, column 4). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 3 shows that all nine radionuclides were reported in other waste streams (column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (column 2 ÷ column 5). This confirms that the unanalyzed radionuclides in canister ECF-01-21-105 will not impact the PA.

Table 3. Unanalyzed radionuclides in waste canister ECF-01-21-105 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Eu-152	1.0434E-06	S	6.49E-07	4.14E+00	2.52E-05	III
Eu-154	3.1018E-06	S	1.93E-06	1.56E+01	1.99E-05	III
Eu-155	8.4755E-07	S	5.28E-07	1.65E+00	5.14E-05	III
H-3	3.3957E-06	S	2.11E-06	1.99E+03	1.71E-07	Retained
Ra-228	3.4354E-13	S	2.14E-13	2.28E-07	1.51E-04	II
Sm-147	2.9822E-15	S	1.86E-15	1.38E-10	2.16E-03	II
Th-228	9.8646E-09	S	6.14E-09	2.02E-04	4.88E-03	III
Th-229	1.074E-12	S	6.68E-13	5.35E-08	2.01E-03	II
Th-230	1.1665E-13	S	7.26E-14	4.93E-08	2.37E-04	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 126 Ci (from RHINO).
NA = Not Applicable. Not included in any base case PA waste streams.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-105 contains one non-system radionuclide (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 4 shows radionuclide Nd-144 is listed as both an activated metal (AM) waste form and surface contamination (SC) in canister ECF-01-21-105. Nd-144 is a non-system radionuclide because of its very long half-life. The long half-life coupled with the very small inventories (< 1E-22 Ci) indicate Nd-144 will not have an impact on the PA.

Table 4. Non-system radionuclides in waste canister ECF-01-21-105.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nd-144	3.78E-24	S	2.3E+15
Nd-144	1.89E-23	A	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-105 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Kira Overin	Kira Overin	1/10/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	1/10/24
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	01/10/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	1/10/2023
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	1/10/2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-086

Subject: Use of heaters on vault shield plugs during waste emplacement operations

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste emplacements in wintertime at the RHLLW Disposal Facility require snow to be removed from vault shield plug (VSP) surfaces in the work area. Often there is a layer of frost and/or ice on the VSPs below the snow that is problematic and makes it difficult to safely perform waste emplacement operations. Aggressive chipping and scraping can remove some ice, but this activity risks damaging the concrete and does not completely remove the hazard and alleviate the risk.

In 2019 at the commencement of disposal operations, use of a heat blanket or heater to melt the ice and create a safer working environment was considered (UDQE-RHLLW-020). It was postulated that this could cause rapid heating of the concrete and temperature gradients that could potentially increase spalling and affect the longevity of the VSPs. At that time, the facility decided that heating would not be used and a full evaluation was not performed. However, hazardous conditions caused by the ice and increased safety concerns have made it necessary to revisit the issue.

It is now proposed that an Allmand Maxi-Heat mobile diesel heater (or similar type equipment) be used to melt the ice prior to waste emplacements. It is believed this methodology can be used to alleviate safety concerns and avoid undue damage to the concrete. The purpose of this UDQE is to evaluate this claim.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☒ No ☐

Comments: The use of heaters to remove ice and snow from the vault tops is proposed as noted in the Description of Proposed Change. The use of heaters must be evaluated to address concerns that their use could negatively impact the longevity of the VSPs.

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☒ Positive ☐

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	2/8/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	2/8/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Allmand Maxi-Heat mobile diesel-fueled heaters are designed to provide heat in harsh environments with two independently operating burners that provide up to 1M BTUs of heat. The UDQE prepared previously for this type of activity (ref UDQE-RHLLW-020) referenced information from the owner's manual of a diesel-powered heater. Although the information was accurate regarding the capabilities of the heater and recognized the potential for damage to the VSP if the concrete was heated too rapidly or to too high a temperature, a test was not completed to document actual temperatures. As a result, a test was conducted to determine the rise in concrete temperature during application of the heater.

The heater (see Figure 1) was placed on an outdoor concrete pad (not a VSP) and operated for seven continuous hours. The heater in the figure is not the exact model that was used for the test, but is the same brand with the same specifications and capabilities as the one in the image. The test began at 8:00 a.m. on 12/7/23. The ambient air temperature (23 °F) and temperature of the concrete at four locations (42 °F) was measured prior to application of the heat and each hour afterward. Concrete temperatures were measured with an Omega X-series Type K thermocouple datalogger/thermometer. Concrete blankets were placed over the heater exit hoses/trunks (2) (see Figure 1) and the concrete surface to trap as much heat as possible. The blankets remained in place for the duration of the test. Location 1 was at the point near the trunk exits. Locations 2, 3 and 4 were approximately 3 to 5 feet from location 1. The uninsulated hose/trunks were approximately 15 and 20 feet long. The maximum flow rate of the heater is 3530 cfm, and the dampers were set at 2.6 out of a maximum of 4 (fully open) corresponding to the flow rate of 2290 cfm. If the exit air temperature reaches the maximum trip point of 230 °F, the fan will continue to run, but the burner will shut down until the exit air temperature reaches 170 °F.

Figure 1: Example of Allmand Maxi-Heat mobile diesel-fueled heater.

Table 1 shows the ambient air temperature and the concrete temperature at four different locations on the concrete.

Table 1. Air temperatures (°F) during heat test.

Time	Ambient Temperature	Location 1 (near trunk exit)	Location 2	Location 3	Location 4
0800	23	42	42	42	42
0900	28	59.1	40.2	29.1	29.7
1000	34	78.4	57	41.8	32
1100	36	99.6	53.7	61.3	57.5
1200	37	101.8	67	67.1	66.8
1300	39	102.2	70.2	74	78.2
1400	40	100.8	71	96.2	77.1
1500	44	108.5	75.5	82	79.8

The code that governs design of nuclear concrete structures (ACI 349) allows for concrete surface temperatures to reach 150°F for the overall structure and 200°F for local hotspots for long term thermal loads. For short term loads such as heating the concrete to melt snow and ice, the code allows temperatures to be 350°F at the surface. Because this concrete is expected to have a much greater design life than typical concrete structures, limiting thermal cycling to the long-term requirement is conservative. TEV-3774 also presents data that at temperatures up to 220°F the strength of modern concrete mixes is reduced by less than 5%. At the code limit of 150°F there is no long-term property degradation of the concrete. TEV-3774 also presents data that shows heating rates of less than 2°C/min or 3.6°F/min, the risk of surface damage is negligible. The maximum temperature shown on the above test was 108.5°F with a maximum heating rate of 0.35°F/min. These are well below the prescribed limits in order to not cause any concrete damage.

Conclusion

Use of the Allmand Maxi-Heat mobile diesel-fueled heater (or similar type equipment) is acceptable for heating VSPs to remove snow and ice and minimize safety concerns as part of waste canister emplacement operations, provided the heater is operated in a manner similar to the testing described in this UDQE. The heater should be used as needed, and only operated for the amount of time required to provide a safe working surface as determined by the shift supervisor (or designee).

References

TEV-3774, "Evaluation of Elevated Temperature Effects on the HFEF Structure from the Blister Anneal Furnace," TEV-3774, Revision 0, Idaho National Laboratory, June 2021.

Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	02/08/2024 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	2/8/24 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	02-08-2024 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul A. Velasquez Signature Waste Management/WMP	2-08-2024 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	2/8/2024 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

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Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-087

Subject: Canister ECF-01-21-103 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-103 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-103 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventory of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
This flag was checked by RHINO because the canister inventory of one radionuclide (Mo-93) exceeds the 10% threshold level of the PA base-case inventory for this generator, waste form and canister type. A threshold of 10% was selected by considering the total number of waste disposal vaults, the variance in expected container radionuclide inventory levels, and other pathway-specific considerations presented in INL (2018). According to INL (2018), if a single container exceeds 10% of the radionuclide-specific base-case inventory modeled in the PA for a specific generator, waste form, and canister type, the container will be flagged for further review to determine if the canister inventory is an anomalous occurrence or indicative of a change in waste generation rates. This check is performed for the 18 key radionuclides listed in Table 18 of INL (2018) that were analyzed in the PA for the groundwater, air and intruder pathways.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because 16 unanalyzed radionuclides with half-lives greater than 1 year, and two non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-01-21-103. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-103 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Print/Type Name	Signature	Date
Kira Overin	*Kira Overin*	1/31/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Timothy Arsenault*	2/1/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10, 11 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-103. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-103

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	1/29/2024
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	1/29/2024
2	Yes	Beta-Gamma DE	9.8157E-005	0.16	mrem/yr	Compliance	1/29/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	1/29/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	1/29/2024
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	1/29/2024
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	1/29/2024
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	1/29/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	1/29/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	1/29/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	1/29/2024
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	1/29/2024
7	Yes	Intruder	1.7338E-001	20	mrem/yr	Compliance	1/29/2024
8	Yes	Air Pathway	1.1029E-004	0.4	mrem/yr	Compliance	1/29/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	1/29/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	1/29/2024
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	1/29/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check.	-			Compliance	1/29/2024
13	Yes	Canister Action Levels Check	-			Compliance	1/29/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: NRF Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	1.2601E-012
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8359E-007	6.9997E-008	9.8595E-011
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1581E-007	3.5211E-008	3.9408E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.1480E-008	4.0123E-008	3.7900E-007
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5365E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9730E-007	3.3543E-009	2.0479E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5723E-005	8.0353E-005	1.0028E-008
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5412E-003	3.8088E-004	1.3677E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5562E-011	3.0840E-012	1.4864E-013
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	
Th-229 [Details]	7.8800E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	2.1758E-018
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1560E-006	4.7761E-007	1.2203E-009
U-235 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6838E-006	5.3927E-009	4.3014E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

11. Administrative 10% Canister Inventory Check (Canister Specific)

Nuclide	Form	Generator	Vault	Array	Amount (Ci)	PA Inv (Ci)	Threshold (Ci)
Mo-93	A	NRF	55-Ton Cask	3	2.6266E-002	2.1131E-001	2.1131E-002

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	4.2209E-008	7.1600E+005	9.7971E-010
Cd-113	A	NRF	3	6.6083E-022	7.7000E+015	1.5338E-023
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	2.4218E-008
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	2.8833E-008
H-3	S	NRF	3	1.3676E-006	1.2300E+001	3.1744E-008
Lu-173	A	NRF	3	1.6031E-011	1.3700E+000	3.7210E-013
Lu-174	A	NRF	3	3.0145E-008	3.3000E+000	6.9968E-010
Mn-53	A	NRF	3	4.5720E-008	3.7400E+006	1.0612E-009
Ra-228	S	NRF	3	3.3747E-013	5.7400E+000	7.8329E-015
Re-186m	A	NRF	3	1.2392E-008	2.0000E+005	2.8763E-010
Sm-147	S	NRF	3	3.2721E-016	1.0600E+011	7.5948E-018
Ta-179	A	NRF	3	1.7436E-010	1.8200E+000	4.0471E-012
Th-228	S	NRF	3	4.5720E-009	1.9100E+000	1.0612E-010
Th-229	S	NRF	3	1.9774E-012	7.8800E+003	4.5896E-014
Th-230	S	NRF	3	2.1427E-013	7.5400E+004	4.9734E-015
Tl-204	A	NRF	3	1.0576E-008	3.7700E+000	2.4549E-010

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	1.7763E-005	A	Yes
Nd-144	4.1943E-027	S	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-103.

PA Check 9

Waste canister ECF-01-21-103 contains nine radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 9 radionuclides, 7 (Ac-227, Cm-245, Cm-246, Hf-178m, Pt-193, Ra-226, and Th-232) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237, and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-103 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-01-21-103 contains nine non-key radionuclides that exceed the PA base case inventory. Six (Cm-245, Cm-246, Hf-178m, Pt-193, Ra-226, and Th-232) were screened during the Phase II PA screening, and 3 (Ac-227, Pu-238 and U-236) were screened during Phase III PA screening. Table 1 shows that the new cumulative inventories of the nine non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-103) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-103 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the non-key radionuclides in ECF-01-21-103 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-103 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-103) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-103 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-103 as % of Max Allowable Phase II Screening Inventory
Cm-245	9.8595E-11	2.8359E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	3.9406E-11	1.1581E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Hf-178m	3.7900E-07	5.1480E-06	4.01E-08	5.19E-06	9.25E+04	4.32E-06	120%
Pt-193	1.0026E-08	9.5723E-05	6.64E-04	7.60E-04	2.92E+02	1.37E-03	55.5%
Ra-226	1.4864E-13	5.5562E-11	3.14E-11	8.70E-11	2.96E+05	1.35E-06	0.006%
Th-232	2.1758E-18	3.0129E-08	2.48E-07	2.78E-07	3.66E+05	1.09E-06	25.5%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-01-21-103 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-103) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-103 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-103 as % of Max Allowable Phase III Screening Inventory
Ac-227	1.2601E-12	2.9789E-07	5.76E-06	6.06E-06	1.00E-40	2.30E+34	2.62E-36%
Pu-238	1.3677E-06	1.5412E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	4.3614E-12	1.6838E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory, the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated.

Impact of Hf-178m on the Groundwater All-Pathways Dose – Hf-178m was modeled using the PA Phase III screening model. A hypothetical inventory of 1 Ci was simulated and the resulting dose was zero. For the PA Phase III screening, all radionuclides that resulted in dose of zero were assigned a dose < 1E-40 mrem/yr. The low dose occurs because Hf-178m has a large sorption coefficient (450 mL/gm) and a relatively short half-life (31 years). If the Hf-178m dose from 1 Ci were 1E-40 mrem/yr, the maximum allowable Phase III inventory according to Equation 2 would be 4E+39 Ci (0.4 mrem/yr x 1 Ci/1E-40 mrem/yr).

Impact of Hf-178m on the Intruder Dose – The inadvertent intruder screening in the PA considered all nuclides that failed the Phase II groundwater pathway screening. Based on the results in Table 1, the projected eventual Hf-178m inventory would fail the PA Phase II screening. The impact of Hf-178m on the intruder pathway was determined by modeling Hf-178m using the same RESRAD computer model (Version 7.2, Yu et al. 2016) used for the PA inadvertent intruder analysis and the same calculations documented in ECAR-2073 (2018). The results show it would take 167,000 Ci of Hf-178m to cause an acute intruder dose of 500 mrem at 100 years (the PA total dose limit), and 33,900 Ci of Hf-178m to cause a chronic intruder dose of 100 mrem/yr at 100 years (the PA total dose limit). 100 years is the time of maximum dose because it is assumed the facility will remain under institutional control for at least 100 years after closure. According to Figure 1, canister ECF-01-21-103 would increase the cumulative Hf-178m inventory in the facility to 5.15E-06 Ci which is approximately 6.5 trillion times less than the maximum allowable.

Hf-178m Summary – Based on the groundwater all-pathways and intruder dose evaluation of Hf-178m, Hf-178m will have no impact on the conclusions of the PA. Given the extreme unlikelihood that the facility Hf-178m inventory could exceed the maximum allowable amounts calculated here for both the groundwater and intruder pathways, it is not necessary to evaluate Hf-178m in future UDQEs when flagged by PA Checks 9 or 11.

PA Check 10

Canister ECF-01-21-103 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathways dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-103. The projected all-pathways dose after disposal of canister ECF-01-21-103 would increase by 0.00000004% for the compliance period and 0.08% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-103 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the intruder dose increase of 28.3% and the air-pathway dose increase of 4.9%. While the increase in the intruder dose is relatively large for one cannister, it is still far less than the performance measure. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-103 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-103.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-103 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-103 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-103
All Pathways Dose	Compliance	mrem/yr	1	25	5.004E-14	1.354E-04	0.00000004%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	6.411E-05	7.884E-02	0.08%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	3.552E-14	9.616E-05	0.00000004%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	6.024E-04	5.597E-02	1.09%
Ra-226/228	Compliance	pCi/L	0.2	5	7.151E-42	2.175E-32	0.00000003%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	8.567E-11	2.030E-06	0.004%
Gross Alpha	Compliance	pCi/L	0.6	15	2.511E-37	4.520E-30	0.000006%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	4.000E-10	6.335E-06	0.006%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	1.944E-14	5.261E-05	0.00000004%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.826E-05	3.062E-02	0.06%
Uranium	Compliance	ug/L	1.2	30	2.364E-34	8.780E-28	0.00003%
Uranium	Post-Compliance	ug/L	15	30	1.887E-08	1.671E-05	0.11%
Intruder	Compliance	mrem/yr	20	100	3.135E-02	1.734E-01	22.07%
Air Pathway	Compliance	mrem/yr	0.4	10	4.923E-06	1.103E-04	4.67%

PA Check 11

Figure 1 shows PA Check 11 was flagged by RHINO because the activated metal (AM) inventory of one radionuclide (Mo-93) in waste canister ECF-01-21-103 exceeds 10% of the base case inventory evaluated in the PA as AM in 55-Ton waste canisters from NRF. This check is only performed for key radionuclides. Mo-93 is a key radionuclide in the PA for the groundwater pathway. If a key radionuclide activity in a waste canister exceeds a 10% threshold activity level for that generator, canister type, and waste stream, the canister is flagged for further review according to the change control process to determine if the radionuclide inventory in the container being evaluated is an anomalous occurrence or indicative of a change in waste generation rates. The canister was also evaluated to determine if the inventory of the radionuclide is within the bounds of the PA.

Table 3 shows the inventory of Mo-93 in canister ECF-01-21-103 exceeds the 10% criteria (12.4%). While this is high for one canister, Table 3 shows that the inventory as a percentage of the total 20-year base case inventory of AM for all generators is low (0.103%, see Column 7). Therefore, the inventory of the radionuclide as AM in canister ECF-01-21-103 is well within the bounds of the PA.

Table 3. Radionuclide inventories in canister ECF-01-21-103 that exceed the 10% criteria for AM in NRF 55-Ton canisters compared to PA 20-year base-case inventories of AM for all generators and canisters.

1	2	3	4	5	6	7
Nuclide	Waste Form[a]	Canister ECF-01-21-103 AM Inventory (Ci)	PA 20-yr Base Case Inventory for SC in NRF 55-Ton Canisters (Ci)	Canister ECF-01-21-103 Inventory as % of PA 20-yr Base Case Inventory for AM in NRF 55-Ton Canisters (Col 3/Col 4)[b]	PA 20-yr Base Case AM Inventory for RHLLW Facility (Ci)	Canister ECF-01-21-103 Inventory as % of PA 20-yr Base Case SC Inventory for RHLLW Facility (Col 3/Col 6)
Mo-93	AM	2.63E-02	2.11E-01	12.4%	2.55E+01	0.103%

a. AM = activated metals
b. Radionuclide flagged by RHINO because percentage exceeds 10%.

To determine if the inventory of the key radionuclide is anomalous compared to other 55-Ton canisters, Table 4 compares the inventory in canister ECF-01-21-103 to the total inventory of AM in the previous ten 55-Ton canisters placed at the facility. Because the percentage in Column 5 is high (81%), the inventories in canister ECF-01-21-103 seem anomalous compared to other 55-Ton canisters previously placed at the facility. Continued tracking is recommended to see if this continues to be the case.

Table 4. Radionuclide inventories in canister ECF-01-21-103 that exceed the 10% criteria for AM in NRF 55-Ton canisters compared to AM inventories in all previously placed 55-Ton canisters.

1	2	3	4	5
Nuclide	Waste Form	Canister Inventory ECF-01-21-103 (Ci)	Inventory in Previously Placed NRF 55-Ton Canisters as AM (Ci)	Canister ECF-01-21-103 Inventory as % of Previously Placed NRF 55-Ton Canisters as SC (Col 3/Col 4)
Mo-93	AM	2.63E-02	3.23E-02	81%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-103 contains 16 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination and activated metals) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these 16 radionuclides when compared to the total canister inventory (4308 Ci) are much less than 1% (see Table 5, column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms.

Column 6 shows that the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventories (column 2 ÷ column 5) with the exception of Tl-204. The total PA base case inventory of Tl-204 is relatively small at 1.10E-22 Ci due to infrequent occurrence of this radionuclide. However, much more than the base case is reported in canister ECF-01-21-103 which warranted further exploration of its impacts to the overall waste stream. The analysis found the sum of the total base case, previously emplaced waste, and canister ECF 01-21-103 inventories of Tl-204 to be nearly 10,000 times smaller than the maximum allowable inventory to be screened out through phase II screening. This confirms that the unanalyzed radionuclides in canister ECF-01-21-103 will not impact the PA.

Seven of the 16 unanalyzed radionuclides have not been previously reported in any other waste stream and were therefore subject to further screening. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6).

Table 5. Unanalyzed radionuclides in waste canister ECF-01-21-103 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Al-26	4.22E-08	AM	9.79E-08%	NA	NA	NA
Cd-113	6.61E-22	AM	1.53E-21%	NA	NA	NA
Eu-152	1.04E-06	SC	2.42E-06%	4.14E+00	0.0025%	III
Eu-154	1.24E-06	SC	2.88E-06%	1.56E+01	0.00080%	III
H-3	5.83E-02	AM	0.14%	1.99E+03	0.29%	Retained
Lu-173	1.60E-11	AM	3.72E-011%	NA	NA	NA
Lu-174	3.01E-08	AM	6.99E-08%	NA	NA	NA
Mn-53	4.57E-08	AM	1.06E-07%	NA	NA	NA
Ra-228	3.37E-13	SC	7.83E-13%	2.28E-07	0.015%	II
Re-186m	1.24E-08	AM	2.87E-08%	NA	NA	NA
Sm-147	3.27E-16	SC	7.59E-16%	1.38E-10	0.024%	II
Ta-179	1.74E-10	AM	4.04E-10%	NA	NA	NA
Th-228	1.39E-10	AM	3.23E-10%	2.02E-04	0.0069%	III
Th-229	1.98E-12	SC	4.58E-12%	5.35E-08	0.37%	II
Th-230	3.29E-11	AM	7.64E-11%	4.93E-08	6.7%	II
Tl-204	1.06E-08	AM	2.45E-08%	1.10E-22	9.61E20%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 4308 Ci (from RHINO).
NA = Not Applicable. Not included in any base case PA waste streams.

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)	Projected Cumulative Inventory after Placement of ECF-01-21-103 + Total PA Base Case Inventory (Cols 3+4) (Ci)	Phase II Screening Factor (mrem/Ci)	Maximum Phase II Screening Inventory (Ci/yr)	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-103 as % of Max Allowable Phase II Screening Inventory
Al-26	4.22E-08	4.36E-09	4.66E-08	1.11E+05	3.60E-06	1.29%
Cd-113	6.61E-22	2.03E-22	8.64E-22	2.07E+05	1.93E-06	4.48E-14
Lu-173	1.60E-11	1.41E-05	1.41E-05	5.55E+02	7.21E-04	1.96%
Lu-174	3.01E-08	3.83E-06	3.86E-06	1.22E+03	3.28E-04	1.18%
Mn-53	4.57E-08	3.67E-09	4.94E-08	1.67E+02	2.40E-03	0.002%
Re-186m	1.24E-08	1.91E-08	3.15E-08	1.37E+04	2.92E-05	0.11%
Ta-179	1.74E-10	2.89E-05	2.89E-05	1.89E+02	2.12E-03	1.36%
Tl-204	1.06E-08	0.00E+00	1.06E-08	4.07E+02	9.83E-04	0.001%

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-103 contains two non-system radionuclides (Nb-91 and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 4 shows radionuclides Nb-91 and Nd-144 are listed as activated metal and surface contamination, respectively, in canister ECF-01-21-103. The long half-life coupled with the very small inventory (< 1E-26 Ci) indicate Nd-144 will not have an impact on the PA.

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The current inventory of Nb-91 is well below 9E+16 Ci.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister ECF-01-21-103 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 4. Non-system radionuclides in waste canister ECF-01-21-103.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nb-91	1.78E-05	AM	680
Nd-144	4.19E-27	SC	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-103 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

Given the extreme unlikelihood that the facility Hf-178m inventory could exceed the maximum allowable amounts presented in this UDQE for both the groundwater and intruder pathways, it is not necessary to evaluate Hf-178m in future UDQEs when flagged by PA Checks 9 or 11.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

ECAR-2073, 2018, "Inadvertent Intruder Analysis for the INL Remote-Handled Low-Level Waste Disposal Facility Performance Assessment," Revision 1, Idaho National Laboratory, January 2018.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

Yu, C., A. J. Zielen, J.-J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H. Peterson, 2016, *RESRAD Version 7.2*, ANL/EAD-4, Argonne National Laboratory.

Print/Type Name	Signature	Date
Kira Overin	Kira Overin	1/31/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	2/1/24
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	02/01/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	02/01/2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	2/1/2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-088

Subject: ATR-5 Canister 814600-13 flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister 814600-13 is an ATR-5 waste canister containing activated metals from the Advanced Test Reactor (ATR) Complex. Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister 814600-13 was flagged by RHINO for the following:

PA Check 12: Waste canister 814600-13 was flagged by RHINO because it contains a radionuclide with a half-life greater than 1 year that was not analyzed in the PA for this particular generator, canister type and waste form. The radionuclide is Co-60 and the waste form is surface contamination.

Radionuclides in a particular waste form from a specific generator, and in a specific canister type that were not considered in the PA fit the definition of a change that must be evaluated before the canister can be accepted according to RH-ADM-5214.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Waste canister 814600-13 was flagged by RHINO while performing PA checks. The flag indicates there is a change from what was considered in the PA that must be evaluated.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	02/13/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	2/13/24
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Waste canister 814600-13 was flagged by RHINO while performing PA checks as part of the acceptance process for disposal. Figure 1 shows the canister details page from RHINO and the results of the PA checks.

Canister Details 814600-13

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: HFEF-5 Can

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	1/30/2024
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	1/30/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	1/30/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	1/30/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	1/30/2024
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	1/30/2024
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	1/30/2024
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	1/30/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	1/30/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	1/30/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	1/30/2024
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	1/30/2024
7	Yes	Intruder	1.4613E-001	20	mrem/yr	Compliance	1/30/2024
8	Yes	Air Pathway	1.0547E-004	0.4	mrem/yr	Compliance	1/30/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	1/30/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	1/30/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	1/30/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	1/30/2024
13	Yes	Canister Action Levels Check	-			Compliance	1/30/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: ATR
Array: All

No Results Found

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Co-60	S	ATR	2	1.1400E-006	5.2600E+000	2.7716E-007

Figure 1. PA Check output screen from RHINO for ATR-5 waste canister 814600-13.

Although Figure 1 shows PA checks 9 and 10 as failed, this is the result of radionuclides from other generators, in other canister types, and waste forms. They were evaluated in previous UDQEs and are not a concern for this evaluation.

PA Check 12: PA check 12 was flagged by RHINO because the canister contains a radionuclide (Co-60) with a half-life greater than 1 year that was not analyzed in the PA for this particular generator (ATR), canister type (ATR-5) and waste form (surface contamination).

During preparation of the PA, the projected radionuclide inventory for ATR-5 waste canisters only included radionuclides in activated metals. No radionuclides were listed as surface contamination. The RHLLW Disposal Facility was notified by the ATR Canal Cleanout Project in 2021 that residual contamination from ATR canal water activity could be present on the surfaces of the activated metals loaded inside the waste baskets and on the inner and outer surfaces of the baskets. The surface contamination radionuclides and relative abundances were obtained from canal chemistry results from 2020 and 2021. The activities were estimated to be minor (uCi or less for individual canisters) and most of the radionuclides that could be present have half-lives less than one year which are not a concern from a PA standpoint. Based on this information, it was decided that surface contamination would be reported, but canister acceptance would be evaluated on a canister-by-canister basis until a more efficient process is developed.

The activity of Co-60 as surface contamination in canister 814600-13 is less than the reporting criteria established in the WAC (PLN-5446). Additionally, the 1.14E-06 Ci of Co-60 as surface contamination in canister 814600-13 is insignificant compared to the amount of Co-60 reported as surface contamination for all generators combined (734 Ci, see PA [DOE-ID 2018], Table 2-14), and the amount of Co-60 reported for all waste forms from all generators (309,000 Ci, see PA [DOE-ID 2018], Table 2-14). Therefore, the Co-60 as surface contamination in canister 814600-13 is within the bounds of the PA and the canister is acceptable for disposal.

> Note: Co-60 is not a key radionuclide for the groundwater pathway in the PA. The amount of Co-60 acceptable from a groundwater pathway perspective is greater than 1E+40 Ci based on the Phase III screening in the PA. However, Co-60 is a key radionuclide for the intruder pathway. Although Co-60 as surface contamination from ATR was not evaluated in the PA, all Co-60 activity regardless of waste form or generator is included in the intruder pathway dose calculated by RHINO. Nevertheless, the inventory of Co-60 as surface contamination in future ATR-5 canisters could be at least 1E+06 times the amount in canister 816400-13 and still be acceptable based on intruder dose performance objectives.

Summary:

Co-60 as surface contamination in canister 814600-13 is within the bounds of the PA and the canister is acceptable for disposal.

Recommendations:

It is recommended the RHLLW disposal project update Table B-1 of PLN-5446, Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility to include the nine radionuclides reported as surface contamination on ATR activated metal components and the waste basket. The appropriate table in RHINO should also be updated to include these nine radionuclides so that RHINO will not flag them as unanalyzed.

References:

DOE-ID 2018, "Performance Assessment for the Idaho National Laboratory Remote Handled Low Level Waste Disposal Facility," DOE/ID-11421, Idaho National Laboratory.

PLN-5546, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory.

Jonathan Jacobson	Jonathan Jacobson	02/13/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	2/14/24
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	02-13-2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	02/13/2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	2/14/24
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-089

Subject: Canister ECF-01-21-109 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-109 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-109 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventory of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because eight unanalyzed radionuclides with half-lives greater than 1 year, and one non-system/non-exempt radionuclide were identified by RHINO in waste canister ECF-01-21-109. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-109 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	2/14/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	2/14/24
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-109. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-109

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	2/7/2024
	Yes	All Pathways Dose	7.8835E-002	12.5	mrem/yr	Post Compliance	2/7/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	2/7/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	2/7/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	2/7/2024
	Yes	Ra-226/228	2.0304E-006	2.5	pCi/L	Post Compliance	2/7/2024
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	2/7/2024
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	2/7/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	2/7/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	2/7/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	2/7/2024
	Yes	Uranium	1.6714E-005	15	ug/L	Post Compliance	2/7/2024
7	Yes	Intruder	1.7454E-001	20	mrem/yr	Compliance	2/7/2024
8	Yes	Air Pathway	1.1857E-004	0.4	mrem/yr	Compliance	2/7/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	2/7/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	2/7/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	2/7/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	2/7/2024
13	Yes	Canister Action Levels Check	-			Compliance	2/7/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold

Generator Facility: NRF   Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9709E-007	2.0884E-007	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3196E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8377E-007	6.9997E-008	1.7624E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1588E-007	3.5211E-008	7.0482E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.1480E-006	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5365E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9732E-007	3.3543E-009	2.5569E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5723E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5435E-003	3.8088E-004	2.2934E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5562E-011	3.0840E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1581E-006	4.7761E-007	2.1268E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6838E-006	6.3927E-009	7.7380E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	6.3804E-007
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	7.5965E-007
H-3	S	NRF	3	1.3676E-006	1.2300E+001	8.3632E-007
Ra-228	S	NRF	3	3.2513E-013	5.7400E+000	1.9882E-013
Sm-147	S	NRF	3	2.8821E-015	1.0600E+011	1.7625E-015
Th-228	S	NRF	3	9.9097E-009	1.9100E+000	6.0600E-009
Th-229	S	NRF	3	9.9217E-013	7.8900E+003	6.0673E-013
Th-230	S	NRF	3	1.0777E-013	7.5400E+004	6.5903E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	3.7796E-024	S	Yes
Nd-144	1.8870E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-109.

PA Check 9

Waste canister ECF-01-21-109 contains 17 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 17 radionuclides, 15 (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-109 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-01-21-109 contains four non-key radionuclides that exceed the PA base case inventory: Cm-245, and Cm-246 (screened during Phase II), and Pu-238 and U-236 (screened during Phase III). Table 1 shows that the new cumulative inventories of the 4 non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-109) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PAi}\,(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-109 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-01-21-109 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-109 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-109) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-109 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-109 as % of Max Allowable Phase II Screening Inventory
Cm-245	1.7624E-10	2.8377E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	7.0482E-11	1.1588E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Radionuclides Screened During PA Phase III Screening							
Key Radionuclide	ECF-01-21-109 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-109) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-109 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-109 as % of Max Allowable Phase III Screening Inventory
Pu-238	2.2934E-06	1.5435E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	7.7380E-12	1.6838E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-01-21-109 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-109. The projected all-pathway dose after disposal of canister ECF-01-21-109 would increase by 0.0000001% for the compliance period and 0.09% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-109 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 7.5%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-109 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-109.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-109 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-109 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-109
All Pathways Dose	Compliance	mrem/yr	1	25	7.858E-14	1.354E-04	0.0000001%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	6.816E-05	7.884E-02	0.09%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	5.579E-14	9.616E-05	0.0000001%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	2.339E-05	5.597E-02	0.04%
Ra-226/228	Compliance	pCi/L	0.2	5	1.012E-41	2.175E-32	0.00000005%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	9.972E-11	2.030E-06	0.005%
Gross Alpha	Compliance	pCi/L	0.6	15	1.628E-37	4.520E-30	0.000004%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	2.341E-10	6.335E-06	0.004%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	3.052E-14	5.261E-05	0.0000001%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.987E-05	3.062E-02	0.06%
Uranium	Compliance	ug/L	1.2	30	1.464E-34	8.780E-28	0.00002%
Uranium	Post-Compliance	ug/L	15	30	2.415E-08	1.671E-05	0.14%
Intruder	Compliance	mrem/yr	20	100	1.168E-03	1.745E-01	0.67%
Air Pathway	Compliance	mrem/yr	0.4	10	8.276E-06	1.186E-04	7.50%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-109 contains eight unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The individual inventories of these eight radionuclides when compared to the total canister inventory (164 Ci) are much less than 1% (see Table 3, column 4). Therefore, with the exception of H-3 (key radionuclide) the inventory of these radionuclides are not reportable according to the WAC. Tritium is a key radionuclide and must be reported if the activity is greater than 1 pCi. Because it is a key radionuclide, the dose contribution of H-3 is accounted for by RHINO. The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. Table 3 shows that all eight radionuclides were reported in other waste streams (column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (column 2 ÷ column 5). This confirms that the unanalyzed radionuclides in canister ECF-01-21-109 will not impact the PA.

Table 3. Unanalyzed radionuclides in waste canister ECF-01-21-109 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Eu-152	1.0434E-06	SC	0.000064%	4.14E+00	0.0025%	III
Eu-154	1.2422E-06	SC	0.000076%	1.56E+01	0.00080%	III
H-3	1.3676E-06	SC	0.000084%	1.99E+03	0.0000069%	Retained
Ra-228	3.2513E-13	SC	2.00E-11%	2.28E-07	0.014%	II
Sm-147	2.8821E-15	SC	1.80E-13%	1.38E-10	0.21%	II
Th-228	9.9097E-09	SC	0.00000061%	2.02E-04	0.49%	III
Th-229	9.9217E-13	SC	6.10E-11%	5.35E-08	0.19%	II
Th-230	1.0777E-13	SC	6.60E-12%	4.93E-08	0.022%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 164 Ci (from RHINO).
NA = Not Applicable. Not included in any base case PA waste streams.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-109 contains one non-system radionuclide (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 4 shows radionuclide Nd-144 is listed as both an activated metal (AM) waste form and surface contamination (SC) in canister ECF-01-21-109. Nd-144 is a non-system radionuclide because of its very long half-life. The long half-life coupled with the very small inventories (< 1E-22 Ci) indicate Nd-144 will not have an impact on the PA.

Table 4. Non-system radionuclides in waste canister ECF-01-21-109.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nd-144	3.78E-24	SC	2.3E+15
Nd-144	1.89E-23	AM	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-109 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	2/15/2024
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	2/14/24
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	02-14-2024
Paul A. Velasquez Waste Management/WMP	Paul A. Velasquez Waste Management/WMP	02/14/24
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	2/14/24

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-090

Subject: Canister MFC240072 from FCF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister MFC240072 is an HFEF-5 can that contains remote handled low-level waste (RHLLW) from the Fuel Conditioning Facility (FCF) hot cell at the Materials and Fuels Complex (MFC). Prior to shipment, waste canisters details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister MFC240072 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)

PA Check 9 was flagged by RHINO because the cumulative inventory of 25 radionuclides (Co-60, Cs-137, Eu-154, Eu-155, I-129, Ni-63, Np-237, Pb-210, Pm-147, Pu-236, Pu-238, Pu-240, Pu-241, Pu-242, Ra-226, Sm-151, Sr-90, Th-229, Th-230, U-232, U-233, U-234, U-235, U-236, and U-238) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (MFC), waste form (combined activated metals with surface contaminated debris) and canister type (HFEF-5). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Eleven of the 25 radionuclides identified by PA Check 9 are not included in the inventory of canister MFC240072 which means these radionuclides were flagged due to previously emplaced waste and the canister inventory of these radionuclides is not relevant to the acceptance process for canister MFC240072. Of the 14 radionuclides included in the inventory of canister MFC240072, 5 are non-key radionuclides, and 9 are key radionuclides. Of the 9 key radionuclides, 4 are key for the intruder pathway, and 5 are key for the groundwater pathway. The 5 non-key radionuclides and the 4 key intruder pathway radionuclides were screened out of the all-pathway (i.e. groundwater pathway) dose calculation during preparation of the PA. The inventory of these radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out of the groundwater pathway evaluation during completion of the PA. Further evaluation of all 9 key radionuclides is addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)

PA Check 10 was flagged by RHINO because the cumulative inventories of 9 key radionuclides exceed performance assessment (PA) base-case inventories for this generator (MFC), waste form (combined activated metals with surface contaminated debris) and canister type (HFEF-5). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister (MFC240072). These nine key radionuclides include 4 intruder pathway radionuclides (Co-60, Cs-137, Ni-63, and Sr-90) and 5 groundwater pathway radionuclides (Np-237, Pu-240, U-234, U-235, and U-238). The inventory of these radionuclides must be evaluated to determine if the increased inventory and accompanying doses are within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)

This flag was checked by RHINO because the canister inventory of one radionuclide (Np-237) exceeds the 10% threshold level of the PA base-case inventory for this generator, waste form and canister type. A threshold of 10% was selected by considering the total number of waste disposal vaults, the variance in expected container radionuclide inventory levels, and other pathway-specific considerations presented in INL (2018). According to INL (2018), if a single container exceeds 10% of the radionuclide-specific base-case inventory modeled in the PA for a specific generator, waste form, and canister type, the container will be flagged for further review to determine if the canister inventory is an anomalous occurrence or indicative of a change in waste generation rates. This check is performed for the 18 key radionuclides listed in Table 18 of INL (2018) that were analyzed in the PA for the groundwater, air and intruder pathways. Np-237 is a key radionuclide for the groundwater pathway.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because unanalyzed radionuclides with half-lives greater than 1 year, and non-system/non-exempt radionuclides were identified by RHINO in waste canister MFC240072. These must be evaluated to confirm the inventories are within the bounds of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister MFC240072 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the canister activities must be evaluated to confirm they are within the bounds of the approved PA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	*Jonathan Jacobson*	3/13/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Timothy Arsenault*	3/13/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, 11 and 12 by RHINO, regarding the inventory of waste canister MFC240072. Figure 1 shows the canisters details page of RHINO and the results of the PA check. It should be noted that radionuclides that were flagged by PA Checks 9 and 10 that are not in canister MFC240072 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister Details MFC240072

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: HFEF-5 Can

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	2/21/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	2/21/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma DE	5.5966E-002	2.4	mrem/yr	Post Compliance	2/21/2024
3	Yes	Ra-226/228	2.1686E-032	0.2	pCi/L	Compliance	2/21/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	2/21/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	2/21/2024
	Yes	Gross Alpha	6.3703E-006	7.5	pCi/L	Post Compliance	2/21/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	2/21/2024
6	Yes	Uranium	8.8768E-028	1.2	ug/L	Compliance	2/21/2024
	Yes	Uranium	1.6801E-005	15	ug/L	Post Compliance	2/21/2024
7	Yes	Intruder	1.7760E-001	20	mrem/yr	Compliance	2/21/2024
8	Yes	Air Pathway	1.1039E-004	0.4	mrem/yr	Compliance	2/21/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	2/21/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	2/21/2024
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	2/21/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	2/21/2024
13	Yes	Canister Action Levels Check	-			Compliance	2/21/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold.

Generator Facility: MFC Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumulative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Co-60 [Details]	5.2600E+000	S	HFEF-5 Can	MFC	2	East	1.5530E+000	7.9130E-001	1.8100E-008
Cs-137 [Details]	3.0100E+001	S	HFEF-5 Can	MFC	2	East	9.3852E+000	3.3673E+000	8.5700E-002
Eu-154 [Details]	8.5900E+000	S	HFEF-5 Can	MFC	2	East	1.1239E-002	8.7567E-003	5.9300E-006
Eu-155 [Details]	4.7500E+000	S	HFEF-5 Can	MFC	2	East	1.2979E-002	8.1631E-003	2.7300E-006
I-129 [Details]	1.5700E+007	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	
Ni-63 [Details]	1.0000E+002	A	HFEF-5 Can	MFC	2	East	8.6515E+003	9.3268E+002	1.7700E+000
Np-237 [Details]	2.1500E+006	S	HFEF-5 Can	MFC	2	East	1.8079E-006	6.8565E-008	7.3500E-009
Pb-210 [Details]	2.2200E+001	S	HFEF-5 Can	MFC	2	East	4.8543E-012	4.6793E-017	
Pm-147 [Details]	2.6200E+000	S	HFEF-5 Can	MFC	2	East	5.0550E-004	1.0081E-004	
Pu-236 [Details]	2.8600E+000	S	HFEF-5 Can	MFC	2	East	9.9498E-007	1.7584E-007	
Pu-238 [Details]	8.7800E+001	S	HFEF-5 Can	MFC	2	East	8.4960E-004	1.6411E-004	1.2800E-005
Pu-240 [Details]	6.5600E+003	S	HFEF-5 Can	MFC	2	East	6.3615E-004	6.1053E-005	3.0600E-006
Pu-241 [Details]	1.4300E+001	S	HFEF-5 Can	MFC	2	East	2.1547E-003	3.0447E-004	8.7300E-006
Pu-242 [Details]	3.7400E+005	S	HFEF-5 Can	MFC	2	East	7.0183E-008	1.7068E-008	
Ra-226 [Details]	1.6000E+003	S	HFEF-5 Can	MFC	2	East	4.1040E-011	4.1920E-018	
Sm-151 [Details]	9.0000E+001	S	HFEF-5 Can	MFC	2	East	4.0232E-003	4.1758E-004	
Sr-90 [Details]	2.8900E+001	S	HFEF-5 Can	MFC	2	East	1.0548E+001	6.7841E+000	4.6300E-003
Th-229 [Details]	7.8800E+003	S	HFEF-5 Can	MFC	2	East	6.5219E-008	1.6644E-015	
Th-230 [Details]	7.5400E+004	S	HFEF-5 Can	MFC	2	East	1.5400E-008	2.1520E-013	
U-232 [Details]	6.8800E+001	S	HFEF-5 Can	MFC	2	East	1.8918E-005	3.4376E-007	
U-233 [Details]	1.5900E+005	S	HFEF-5 Can	MFC	2	East	3.0607E-005	3.3797E-006	
U-234 [Details]	2.4600E+005	S	HFEF-5 Can	MFC	2	East	2.2800E-004	1.1728E-004	1.3800E-008
U-235 [Details]	7.0300E+008	S	HFEF-5 Can	MFC	2	East	3.0135E-006	1.8162E-006	5.7500E-008
U-236 [Details]	2.3400E+007	S	HFEF-5 Can	MFC	2	East	4.7584E-006	2.3053E-006	6.0300E-008
U-238 [Details]	4.4700E+009	S	HFEF-5 Can	MFC	2	East	2.0314E-006	9.1146E-007	1.9000E-008

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

11. Administrative 10% Canister Inventory Check (Canister Specific)

Nuclide	Form	Generator	Vault	Array	Amount (Ci)	PA Inv (Ci)	Threshold (Ci)
Np-237	S	MFC	HFEF-5 Can	2	7.3500E-009	6.8565E-008	6.8565E-009

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
C-14	S	MFC	2	2.4500E-007	5.7000E+003	8.8302E-006
Fe-55	S	MFC	2	1.1100E-006	2.7400E+000	4.0063E-005
Nb-92	A	MFC	2	3.4000E-007	3.4900E+007	1.2500E-005
Nb-93m	A	MFC	2	3.8700E-002	1.6100E+001	1.3981E+000
Ni-63	S	MFC	2	6.0000E-007	1.0000E+002	2.4134E-005
Np-237	S	MFC	2	7.3500E-009	2.1500E+006	2.6515E-007
Si-32	A	MFC	2	3.1100E-007	1.5300E+002	1.1219E-005
Tc-98	A	MFC	2	6.4400E-010	4.2100E+006	2.3232E-008
Tc-99	A	MFC	2	2.5700E-003	2.1100E+005	8.6218E-006
Zr-93	A	MFC	2	7.2900E-008	1.5300E+006	2.6298E-006

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	9.4000E-004	A	Yes

Figure 1. Canister Details page of RHINO and the results of the PA checks for canister MFC240072 Summary of canister checks flagged by RHINO that require evaluation.

PA Check 9

Waste canister MFC240072 contains 14 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (HFEF-5) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 14 radionuclides, 5 are non-key radionuclides, and 9 are key radionuclides. Key radionuclides are shown in bold font in the details section of PA Checks 9 and 10 of Figure 1. Of the 9 key radionuclides, 4 are key for the intruder pathway, and 5 are key for the groundwater pathway. The 5 non-key radionuclides and the 4 key intruder pathway radionuclides were screened out of the all-pathways (i.e. groundwater pathway) dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out of the groundwater pathway during preparation of the PA. Further evaluation of all 9 key radionuclides is addressed under PA Check 10 (see below).

Canister MFC240072 contains 5 non-key radionuclides and 4 key intruder pathway that exceed the PA base case inventory and were screened from the all-pathways (i.e. groundwater pathway) dose calculations during preparation of the PA. None were screened during the Phase II PA screening, and all 9 (Co-60, Cs-137, Eu-154, Eu-155, Ni-63, Pu-238, Pu-241, Sr-90, and U-236) were screened during Phase III PA groundwater screening. Table 1 shows that the new cumulative inventories of the 9 radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. Although none of the 9 radionuclides were screened during the Phase II screening, equations for both Phases II and III are included below for completeness.

For this calculation the inventory of all placed canisters plus the proposed canister (MFC240072) was added to the total PA base case inventory. This is conservative because the PA base case inventories include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose\ Factor_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister MFC240072 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Thus, the inventories of the non-key radionuclides in MFC240072 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	MFC240072 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + MFC240072) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of MFC240072 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of MFC240072 as % of Max Allowable Phase II Screening Inventory
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	MFC240072 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + MFC240072) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of MFC240072 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of MFC240072 as % of Max Allowable Phase III Screening Inventory
Co-60	1.81E-08	1.5539E+00	3.09E+05	3.09E+05	1.00E-40	1.24E+45	2.50E-38%
Cs-137	8.57E-02	9.3952E+00	9.45E+02	9.54E+02	1.00E-40	3.78E+42	2.52E-38%
Eu-154	5.93E-06	1.1239E-02	1.56E+01	1.56E+01	1.00E-40	6.24E+40	2.50E-38%
Eu-155	2.73E-06	1.2979E-02	1.65E+00	1.66E+00	1.00E-40	6.60E+39	2.52E-38%
Ni-63	1.77E+00	8.6515E+03	2.18E+05	2.27E+05	1.00E-40	8.72E+44	2.60E-38%
Pu-238	1.28E-05	8.4968E-04	3.68E-01	3.69E-01	2.57E-02	5.73E+00	6.44%
Pu-241	8.73E-06	2.1847E-03	1.97E+01	1.97E+01	4.32E-02	1.82E+02	10.8%
Sr-90	4.63E-03	1.8546E+01	6.73E+02	6.92E+02	1.00E-40	2.69E+42	2.57E-38%
U-236	6.03E-08	4.7584E-06	5.88E-05	6.36E-05	1.04E-02	2.26E-03	2.81%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister MFC240072 contains 5 key groundwater pathway radionuclides (Np-237, Pu-240, U-234, U-235, and U-238) and 4 key intruder pathway radionuclides (Co-60, Cs-137, Ni-63, and Sr-90) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (MFC), canister type (HFEF-5) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out of their respective pathways during preparation of the PA. The contributions of the key groundwater pathway radionuclides are included in the RHINO all-pathways dose calculation and other performance measures (Gross alpha, Uranium). The contribution of the 4 key intruder pathway radionuclides is reflected only in the intruder pathway dose.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister MFC240072. The projected all-pathways dose after disposal of canister MFC240072 would increase by 0.0004% for the compliance period and 0.0014% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of MFC240072 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increase of other performance measures, including the intruder dose, are also very small and within the bounds of the PA. Thus, this evaluation shows that although the cumulative inventories of several key radionuclides would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister MFC240072 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister MFC240072.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister MFC240072 (mrem/yr)	Placed Canisters + Proposed Canister MFC240072 (mrem/yr)	% Increase in Perfomance Measure Dose After Placement of MFC240072
All Pathways Dose	Compliance	mrem/yr	1	25	5.329E-10	1.354E-04	0.0004%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	1.126E-06	7.884E-02	0.0014%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	3.785E-10	9.616E-05	0.0004%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	6.682E-07	5.597E-02	0.0012%
Ra-226/228	Compliance	pCi/L	0.2	5	1.305E-34	2.188E-32	0.60%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.219E-08	2.043E-06	0.60%
Gross Alpha	Compliance	pCi/L	0.6	15	2.930E-32	4.549E-30	0.65%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	3.534E-08	6.370E-06	0.56%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	2.071E-10	5.261E-05	0.0004%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	3.656E-07	3.062E-02	0.0012%
Uranium	Compliance	ug/L	1.2	30	9.899E-30	8.879E-28	1.13%
Uranium	Post-Compliance	ug/L	15	30	1.870E-07	1.690E-05	1.12%
Intruder	Compliance	mrem/yr	20	100	1.197E-04	1.776E-01	0.07%
Air Pathway	Compliance	mrem/yr	0.4	10	2.868E-10	1.104E-04	0.0003%

PA Check 11

Figure 1 shows PA Check 11 was flagged by RHINO because the surface contamination (SC) inventory of one radionuclide (Np-237), in waste canister MFC240072 exceeds 10% of the base case inventory evaluated in the PA as SC in HFEF-5 waste canisters from MFC. This check is only performed for key radionuclides. Np-237 is a key radionuclide in the PA for the groundwater pathway. If a key radionuclide activity in a waste canister exceeds a 10% threshold activity level for that generator, canister type, and waste stream, the canister is flagged for further review according to the change control process to determine if the radionuclide inventory in the container being evaluated is an anomalous occurrence or indicative of a change in waste generation rates. The canister was also evaluated to determine if the inventory of the radionuclide is within the bounds of the PA.

Table 3 shows the inventory of Np-237 in canister MFC240072 as SC exceeds the 10% criteria (10.7%). While this is high for one canister, Table 3 shows that the inventory as a percentage of the total 20-year base case inventory of SC for all generators is low (0.0013%, see Column 7). Therefore, the inventory of the radionuclide as SC in canister MFC240072 is well within the bounds of the PA.

Table 3. Radionuclide inventories in canister MFC240072 that exceed the 10% criteria for SC in MFC HFEF-5 canisters compared to PA 20-year base-case inventories of SC for all MFC HFEF-5 canisters and SC from all generators.

1	2	3	4	5	6	7
Nuclide	Waste Form[a]	Canister MFC240072 SC Inventory (Ci)	PA 20-yr Base Case Inventory for SC in MFC HFEF-5 Canisters (Ci)	Canister MFC240072 Inventory as % of PA 20-yr Base Case Inventory for SC in MFC HFEF-5 Canisters (Col 3/Col 4)[b]	PA 20-yr Base Case of SC Inventory for All Generators (Ci)	Canister MFC240072 Inventory as % of PA 20-yr Base Case SC Inventory for All Generators (Col 3/Col 6)
Np-237	SC	7.35E-09	6.86E-08	10.7%	5.82E-04	0.0013%

a. SC = surface contamination
b. Radionuclide flagged by RHINO because percentage exceeds 10%.

To determine if the inventory of the key radionuclide is anomalous compared to other HFEF-5 canisters, Table 4 compares the inventory in canister MFC240072 to the average Np-237 inventory as SC in previous HFEF-5 canisters placed at the facility. The comparison shows the Np-237 inventory in canister MFC240072 is less than the average inventory of Np-237 in previously place HFEF-5 canisters. So although the Np-237 in canister MFC240072 exceeds the 10% criteria, it is actually less than the average inventory of previously placed canisters indicating the original estimation for the 20-year proposed inventory of Np-237 was low. Continued tracking is recommended to see if this continues to be the case.

Table 4. Radionuclide inventories in canister MFC240072 that exceed the 10% criteria for SC in MFC HFEF-5 canisters compared to SC inventories in all previously placed HFEF-5 canisters.

1	2	3	4	5	6
Nuclide	Waste Form	Canister Inventory MFC HFEF-5 (Ci)	Number of Placed MFC HFEF-5 Canisters	Inventory in Previously Placed MFC HFEF-5 Canisters as SC (Ci)	Average Np-237 Inventory in Previously Placed MFC HFEF-5 Canisters as SC (Ci) (Col 5/Col 4)[a]
Np-237	SC	7.35E-09	65	1.80E-06	2.77E-08

a. Based on 1.8E-06 Ci in 65 total HFEF-5 canisters as of 3/1/2024.

PA Check 12: Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister MFC240072 contains 10 unanalyzed radionuclides (C-14, Fe-55, Nb-92, Nb-93m, Ni-63, Np-237, Si-32, Tc-98, Tc-99, Zr-93) with half-lives greater than one year. These radionuclides from this generator in these particular waste forms were not reported in the PA base-case inventory and were not analyzed in the PA. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

It is not necessary to evaluate Np-237 because it is a key radionuclide and was also analyzed in the PA for the HFEF-5 legacy waste stream. After the PA was completed, RHINO was programmed to track "legacy" waste in HFEF-5 canisters separate from "new-generation" waste in HFEF-5 canisters. However, the project has decided that because there is no difference in how these two waste streams are treated in the PA, they should be treated as the same waste streams in terms of how they are analyzed and flagged by RHINO. As a result, RHINO will be modified to treat them similarly in terms of identifying unanalyzed radionuclides. And because Np-237 was identified as SC in the legacy waste stream and RHINO includes the contribution in calculating performance measures, it should not be identified as unanalyzed in the new-generation waste stream. Therefore, there is no need to analyze the inventory of Np-237.

To confirm the inventories of the remaining 9 unanalyzed radionuclides are within the bounds of the PA, the inventories of individual radionuclides were compared to the total radionuclide canister inventory (in Ci), and also to the total PA base case inventories in all waste forms. The inventories of the 9 unanalyzed radionuclides when compared to the total canister inventory (2.77 Ci) are less than 1% (see Figure 1) with the exception of Nb-93m (1.4%) and Tc-99 (0.093%). But when the canister inventories are compared to the total PA base case inventory of all waste forms, the percentages of Nb-93m (0.0007%) and Tc-99 (0.05%) are quite low. The Nb-93 inventory will not impact the PA as this radionuclide was screened out during the Phase III screening with a screening dose of <1E-40 mrem/yr. The Tc-99 inventory will have a small impact on the all-pathways dose, but the impact will be calculated by RHINO because it is a key radionuclide for the groundwater pathway.

When the canister inventories are compared to the total PA base case inventories of all generators and waste forms (Table 5, column 6), the percentages of the other radionuclides are very low except for Nb-92 (7.88%) and Si-32 (94.8%). The percentages of Nb-92 and Si-32 are only large because the PA base case inventories of these 2 radionuclides are relatively small. To be sure the inventories will not impact the PA, the canister inventories for these two radionuclides were compared to the maximum allowable inventories calculated using the Phase II screening model (for Si-32) and the Phase III screening model (for Nb-92), the same phases they were screened from the PA. These calculations were performed using Equations 1 and 2 (See PA Check 9 section). The canister inventory of Nb-92 (3.49E-07 Ci) is 6E-06% of the maximum inventory allowed by Phase III screening. The canister inventory of Si-32 (3.11E-07 Ci) is 4.6% of the maximum inventory allowed by Phase II screening. Although the Si-32 is a high percentage of the maximum allowable, it was screened during Phase II and the likely percentage allowed by Phase III would be very small.

Based on these comparisons the unanalyzed radionuclide inventories identified by RHINO in canister MFC240072 will have an insignificant impact on the PA. Again, any impacts from key radionuclides will be included by RHINO in the appropriate dose and concentration calculations [C-14 (groundwater, air), Ni-63 (intruder), Np-237 (groundwater), and Tc-99 (groundwater)].

Table 5. Unanalyzed radionuclides in waste canister MFC240072 with half-lives greater than one year.

1	2	3	4	5	6
Radionuclide	Canister Inventory (Ci)	Waste Form	Radionuclide Inventory as % of Total Canister Inventory	Total PA Base Case Inventory All Waste Forms(Ci)	Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)
C-14	2.45E-07	SC	8.84E-06%	2.14E+02	1.14E-07%
Fe-55	1.11E-06	SC	4.00E-05%	1.97E+05	5.63E-10%
Nb-92	3.49E-07	AM	1.26E-05%	4.43E-06	7.88%
Nb-93m	3.87E-02	AM	1.40%	5.70E+02	0.00679%
Ni-63	6.69E-07	SC	2.40E-05%	2.18E+05	3.07E-10%
Si-32	3.11E-07	AM	1.12E-05%	3.28E-07	94.8%
Tc-98	6.44E-10	AM	2.32E-08%	1.23E-07	0.52%
Tc-99	2.57E-03	AM	0.093%	5.24E+00	0.05%
Zr-93	7.98E-02	AM	2.63E-06%	2.22E+01	0.000033%

PA Check 12: Non-System Radionuclides

Figure 1 shows waste canister MFC240072 contains one non-system radionuclide (Nb-91). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 5 shows Nb-91 is listed as an activated metal in canister MFC240072.

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The current inventory of Nb-91 is well below 9E+16 Ci.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister MFC240072 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 5. Non-system radionuclides in waste canister MFC240072.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nb-91	9.40E-04	AM	680

a. AM = Activated Metal

Summary

The radionuclide inventory of waste canister MFC240072 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

Recommendations

Modify RHINO to identify unanalyzed radionuclides in legacy and new-generation HFEF-5 canisters using the combined list of radionuclides from both legacy and new-generation HFEF-5 canisters.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

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Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	03/13/2024 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	3/13/24 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	03/12/2024 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul A. Velasquez Signature Waste Management/WMP	03/13/24 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	3/13/2024 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-091

Subject: Canister ECF-01-21-111 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-111 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-111 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventory of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because 12 unanalyzed radionuclides with half-lives greater than 1 year, and three non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-01-21-111. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

   Yes ☒ No ☐

Comments: Canister ECF-01-21-111 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

   Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	04/04/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	04/09/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-111. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-111

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	2/21/2024
	Yes	All Pathways Dose	7.8838E-002	12.5	mrem/yr	Post Compliance	2/21/2024
2	Yes	Beta-Gamma DE	9.5157E-005	0.16	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma DE	5.5966E-002	2.4	mrem/yr	Post Compliance	2/21/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	2/21/2024
	Yes	Ra-226/228	2.0304E-005	2.5	pCi/L	Post Compliance	2/21/2024
4	Yes	Gross Alpha	4.5198E-030	0.6	pCi/L	Compliance	2/21/2024
	Yes	Gross Alpha	6.3351E-006	7.5	pCi/L	Post Compliance	2/21/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	2/21/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	2/21/2024
	Yes	Uranium	1.8714E-005	15	ug/L	Post Compliance	2/21/2024
7	Yes	Intruder	1.8316E-001	20	mrem/yr	Compliance	2/21/2024
8	Yes	Air Pathway	1.2019E-004	0.4	mrem/yr	Compliance	2/21/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	2/21/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	2/21/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	2/21/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	2/21/2024
13	Yes	Canister Action Levels Check	-			Compliance	2/21/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold

Generator Facility: NRF
Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	2.0150E-013
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4000E+003	S	55-Ton Cask	NRF	3	West	2.8380E-007	5.9907E-008	2.0521E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1590E-007	3.5211E-008	8.3240E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.1400E-008	4.0123E-008	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
La-137 [Details]	6.0000E+004	A	55-Ton Cask	NRF	3	West	4.6365E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9733E-007	3.3543E-009	3.2044E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.6723E-006	9.0353E-006	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.6438E-003	3.8088E-004	2.5793E-008
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5570E-011	3.0840E-012	1.0147E-014
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9137E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.8443E-007	1.0867E-007	
Th-229 [Details]	7.8800E+003	A	55-Ton Cask	NRF	3	West	2.6308E-008	2.5094E-009	4.8370E-016
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.8022E-008	3.3524E-020
U-234 [Details]	2.4500E+005	S	55-Ton Cask	NRF	3	West	5.1585E-006	4.7761E-007	2.5386E-009
U-238 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6038E-008	5.3927E-009	9.1673E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	4.2668E-008	7.1600E+005	3.9979E-009
Cd-113	A	NRF	3	4.4916E-024	7.7000E+015	4.2100E-028
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	9.7982E-008
Eu-154	S	NRF	3	1.2422E-006	8.6000E+000	1.1666E-007
H-3	S	NRF	3	1.3676E-006	1.2300E+001	1.2843E-007
Mn-53	A	NRF	3	2.0512E-008	3.7400E+006	1.9263E-009
Ra-228	S	NRF	3	4.6514E-013	5.7400E+000	4.3680E-014
Sm-147	S	NRF	3	3.8016E-015	1.0600E+011	3.5701E-016
Th-228	S	NRF	3	1.1403E-008	1.9100E+000	1.0708E-009
Th-229	S	NRF	3	1.5519E-012	7.8800E+003	1.4574E-013
Th-230	S	NRF	3	1.6960E-013	7.5400E+004	1.5927E-014
Tl-204	A	NRF	3	6.4822E-008	3.7700E+000	6.0867E-009

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	8.1580E-020	A	Yes
Nb-91m	4.7341E-020	A	Yes
Nd-144	4.4096E-024	S	Yes
Nd-144	4.4460E-028	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-111.

PA Check 9

Waste canister ECF-01-21-111 contains 10 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 10 radionuclides, 8 (Ac-227, Cm-245, Cm-246, Pu-238, Ra-226, Th-229, Th-232, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237 and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-111 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-01-21-111 contains eight non-key radionuclides that exceed the PA base case inventory: Cm-245, Cm-246, Ra-226, Th-229, and Th-232 (screened during Phase II), and Ac-227, Pu-238 and U-236 (screened during Phase III). Table 1 shows that the new cumulative inventories of the eight non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-111) was added to the total PA base case inventory. This is conservative because the PA base case inventories include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose\ Factor_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x\ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-111 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out. Therefore, the inventories of the non-key radionuclides in ECF-01-21-111 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-111 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-111) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-111 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-111 as % of Max Allowable Phase II Screening Inventory
Cm-245	2.08E-10	2.84E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	8.32E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Ra-226	1.61E-14	5.56E-11	3.14E-11	8.70E-11	2.96E+05	1.35E-06	0.0064%
Th-229	4.64E-15	2.84E-08	5.35E-08	8.19E-08	1.18E+05	3.38E-06	2.42%
Th-232	3.36E-20	3.01E-08	2.48E-07	2.78E-07	3.66E+05	1.09E-06	25.5%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-01-21-111 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-111) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-111 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-111 as % of Max Allowable Phase III Screening Inventory
Ac-227	2.02E-13	2.98E-07	5.76E-06	6.06E-06	1.00E-40	2.30E+34	2.63E-38%
Pu-238	2.58E-06	1.54E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	9.17E-12	1.68E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

PA Check 10

Canister ECF-01-21-111 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathway dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-111. The projected all-pathway dose after disposal of canister ECF-01-21-111 would increase by 6.67E-08% for the compliance period and 0.11% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-111 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 8.88%. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-111 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-111.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-111 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-111 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-111
All Pathways Dose	Compliance	mrem/yr	1	25	9.034E-14	1.354E-04	6.67E-08%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	8.357E-05	7.884E-02	0.11%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	6.414E-14	9.616E-05	6.67E-08%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	9.629E-05	5.597E-02	0.17%
Ra-226/228	Compliance	pCi/L	0.2	5	9.609E-42	2.175E-32	4.4E-08%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	5.240E-11	2.030E-06	0.0026%
Gross Alpha	Compliance	pCi/L	0.6	15	4.554E-38	4.520E-30	1.01E-06%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	1.788E-10	6.335E-06	0.003%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	3.509E-14	5.261E-05	6.67E-08%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	2.419E-05	3.062E-02	0.079%
Uranium	Compliance	ug/L	1.2	30	4.074E-35	8.780E-28	4.64E06%
Uranium	Post-Compliance	ug/L	15	30	8.660E-09	1.671E-05	0.052%
Intruder	Compliance	mrem/yr	20	100	5.679E-03	1.832E-01	3.20%
Air Pathway	Compliance	mrem/yr	0.4	10	9.803E-06	1.202E-04	8.88%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-111 contains 12 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (activated metals with surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA. Tritium, however, is a key radionuclide and the dose contribution is accounted for by RHINO. Therefore, tritium does not require evaluation.

The inventory of the other radionuclides will not have an impact on the PA. To confirm this, the canister inventories were compared to the total PA base case inventories of all waste forms. When the canister inventories are compared to the total PA base case inventories of all generators and waste forms (Table 3, Column 6), the percentages of all radionuclides are very small except for Tl-204 (5.90E16%). The percentage of Tl-204 is large because the PA inventory of this radionuclide is very small (1.1E-22 Ci). To be sure the inventory will not impact the PA, the canister inventory was compared to the maximum allowable inventory calculated using the Phase II screening model, the same phase it was screened from the PA. This calculation was performed using Equation 1 (See PA Check 9 section). The canister inventory of Tl-204 (6.49E-08 Ci) is 0.0068% of the maximum inventory allowed by Phase II screening, indicating there will not be an impact to the PA.

Table 3 shows that nine of the 12 radionuclides were reported in other waste streams (column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (column 2 ÷ column 5). This confirms that the unanalyzed radionuclides in canister ECF-01-21-111 will not impact the PA.

Table 3. Evaluation summary of unanalyzed radionuclides in waste canister ECF-01-21-111 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Al-26	4.26E-08	AM	4.00E-09%	N/A	N/A	N/A
Cd-113	4.49E-24	AM	4.22E-25%	N/A	N/A	N/A
Eu-152	1.04E-06	SC	9.80E-08%	4.14E+00	2.52E-05%	III
Eu-154	1.24E-06	SC	1.17E-07%	1.56E+01	7.96E-06%	III
H-3	1.37E-06	SC	1.28E-07%	1.99E+03	6.87E-08%	Retained
Mn-53	2.05E-08	AM	1.93E-09%	N/A	N/A	N/A
Ra-228	4.65E-13	SC	4.37E-14%	2.28E-07	0.000204%	II
Sm-147	3.80E-15	SC	3.57E-16%	1.38E-10	0.003%	II
Th-228	1.15E-08	SC	1.08E-09%	2.02E-04	0.006%	III
Th-229	1.55E-12	SC	1.46E-13%	5.35E-08	0.003%	II
Th-230	1.70E-13	SC	1.59E-14%	4.93E-08	0.0003%	II
Tl-204	6.49E-08	AM	6.10E-09%	1.10E-22	5.90E+16%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 1065 Ci (from RHINO).
N/A = Not Applicable. Not included in any base case PA waste streams.

Three of the 12 unanalyzed radionuclides have not been previously reported in any other waste stream and were therefore subject to further review. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus, these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 4).

Table 4. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories.

1	2	3	4	5	6
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Phase II Screening Factor (mrem/Ci)	Maximum Phase II Screening Inventory (Ci/yr)	Percent Canister Inventory of Maximum Allowable Phase II Screening Inventory
Al-26	4.26E-08	AM	1.11E+05	3.60E-06	1.18%
Cd-113	4.49E-24	AM	2.07E+05	1.93E-06	2.33E-16%
Mn-53	2.05E-08	AM	1.67E+02	2.40E-03	0.00085%

a. AM = Activated Metal
N/A = Not Applicable. Not included in any base case PA waste streams.

The maximum phase II screening inventory (Column 5) is calculated using maximum allowable inventory (equation 1). All of the values in column 6, percent canister inventory of maximum allowable phase II screening inventory, are very small and not reported in any previous canisters. If these radionuclides appear in later waste canisters, the same calculation will be performed, however it will be done on a cumulative basis rather than by individual waste canister.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-111 contains three non-system radionuclides (Nb-91, Nb-91m and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 5 shows radionuclides Nb-91 and Nb-91m are listed as activated metals, and Nd-144 is listed as both activated metal and surface contamination, in canister ECF-01-21-111. The long half-life of Nd-144 coupled with the very small inventory (< 1E-26 Ci) indicate it will not have an impact on the PA. The inclusion of Nb-91m in waste canister ECF-01-21-111 would not affect the assumptions of the PA due to the very small inventory (4.73E-20 Ci) and short half-life (less than one year).

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The current inventory of Nb-91 is well below 9E+16 Ci.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic intruder dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario, and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister ECF-01-21-111 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 5. Non-system radionuclides in waste canister ECF-01-21-111.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nb-91	8.16E-06	AM	680
Nb-91m	4.73E-20	AM	0.164
Nd-144	4.41E-24	SC	2.3E+15
Nd-144	4.45E-26	AM	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-111 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

Print/Type Name	Signature	Date
Jonathan Jacobson	Jonathan Jacobson	04/09/2024
Originator/FDS	Originator/FDS	
A. R. Prather	A. R. Prather	4/9/24
System Engineer/SE	System Engineer/SE	
A. Jeff Sondrup	Jeff Sondrup	04/09/2024
PA/CA SME	PA/CA SME	
Paul A. Velasquez	Paul A. Velasquez	04/09/2024
Waste Management/WMP	Waste Management/WMP	
Tim Arsenault	Timothy Arsenault	04/09/2024
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-092

Subject: Canister ECF-01-21-106 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-106 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-106 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventories of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Nine of the 17 radionuclides flagged in PA check 9 and present in ECF-01-21-106 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The nine non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these two key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
This flag was checked by RHINO because the canister inventory of one radionuclide (Mo-93) exceeds the 10% threshold level of the PA base-case inventory for this generator, waste form and canister type. A threshold of 10% was selected by considering the total number of waste disposal vaults, the variance in expected container radionuclide inventory levels, and other pathway-specific considerations presented in INL (2018). According to INL (2018), if a single container exceeds 10% of the radionuclide-specific base-case inventory modeled in the PA for a specific generator, waste form, and canister type, the container will be flagged for further review to determine if the canister inventory is an anomalous occurrence or indicative of a change in waste generation rates. This check is performed for the 18 key radionuclides listed in Table 18 of INL (2018) that were analyzed in the PA for the groundwater, air and intruder pathways.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because 16 unanalyzed radionuclides with half-lives greater than 1 year, and two non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-01-21-106. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-106 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	4/16/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault	4/16/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

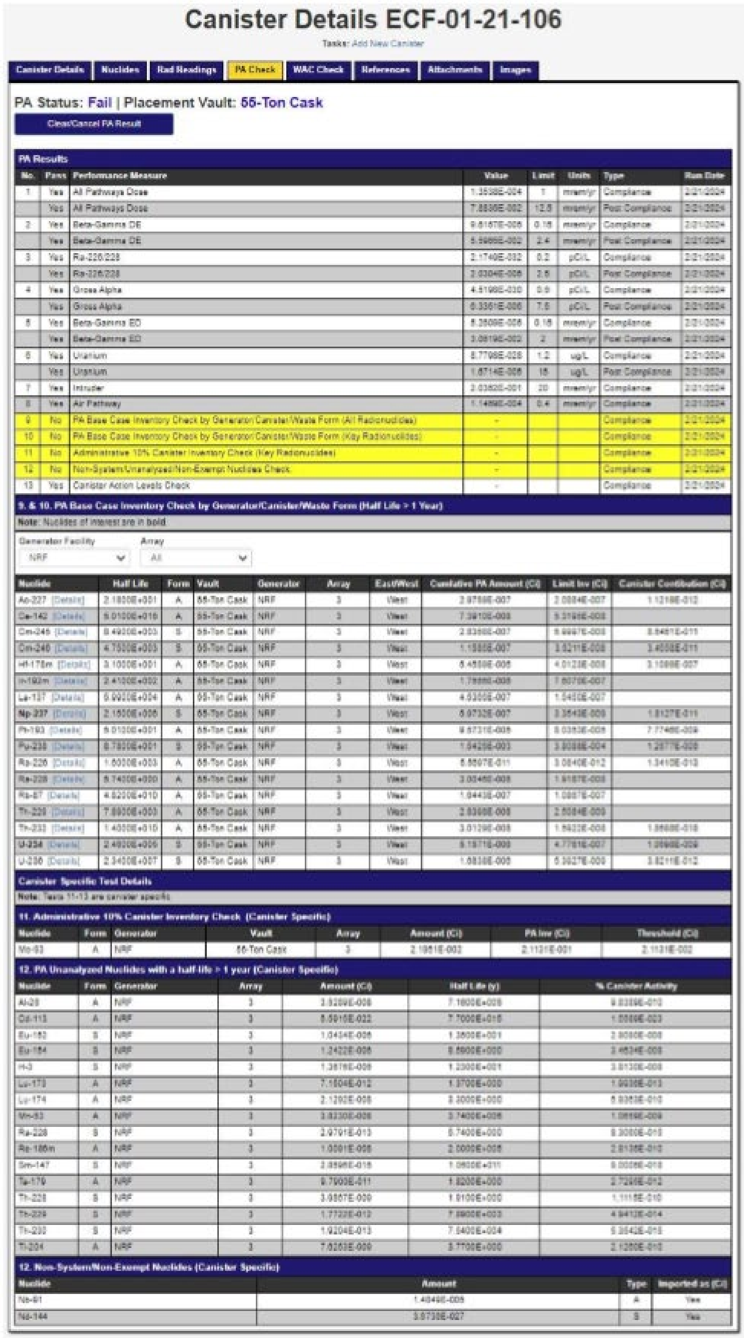
Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10, 11 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-106. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY



Canister Details ECF-01-21-106

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	2/21/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	2/21/2024
2	Yes	Beta-Gamma DE	9.8167E-008	0.18	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma DE	5.5985E-002	2.4	mrem/yr	Post Compliance	2/21/2024
3	Yes	Ra-226/228	2.1749E-032	0.2	pCi/L	Compliance	2/21/2024
	Yes	Ra-226/228	2.0304E-008	2.5	pCi/L	Post Compliance	2/21/2024
4	Yes	Gross Alpha	4.5199E-030	0.9	pCi/L	Compliance	2/21/2024
	Yes	Gross Alpha	6.3361E-008	7.5	pCi/L	Post Compliance	2/21/2024
5	Yes	Beta-Gamma ED	8.2509E-008	0.18	mrem/yr	Compliance	2/21/2024
	Yes	Beta-Gamma ED	3.0819E-002	2	mrem/yr	Post Compliance	2/21/2024
6	Yes	Uranium	8.7798E-028	1.2	ug/L	Compliance	2/21/2024
	Yes	Uranium	1.8714E-008	15	ug/L	Post Compliance	2/21/2024
7	Yes	Intruder	2.0382E-001	20	mrem/yr	Compliance	2/21/2024
8	Yes	Air Pathway	1.1489E-004	0.4	mrem/yr	Compliance	2/21/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	2/21/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	2/21/2024
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	2/21/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	2/21/2024
13	Yes	Canister Action Levels Check	-			Compliance	2/21/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold

Generator Facility: NRF | Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9759E-007	2.0084E-007	1.1218E-012
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3198E-008	
Cm-245 [Details]	8.4920E+003	S	55-Ton Cask	NRF	3	West	2.8350E-007	8.9997E-008	8.8481E-011
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1585E-007	3.8211E-008	3.4058E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.4550E-008	4.0123E-008	3.1089E-007
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7989E-008	7.8079E-007	
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.0300E-007	1.0450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	8.9732E-007	3.3543E-009	1.8127E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.8731E-008	8.0353E-008	7.7748E-009
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.0425E-003	3.8088E-004	1.2877E-008
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	8.8897E-011	3.0840E-012	1.3410E-013
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0045E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.0443E-007	1.0887E-007	
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.8422E-008	1.8668E-018
U-234 [Details]	2.4500E+005	S	55-Ton Cask	NRF	3	West	5.1977E-008	4.7781E-007	1.0898E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6838E-008	5.3627E-009	3.8211E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific

11. Administrative 10% Canister Inventory Check (Canister Specific)

Nuclide	Form	Generator	Vault	Array	Amount (Ci)	PA Inv (Ci)	Threshold (Ci)
Mo-93	A	NRF	55-Ton Cask	3	2.1951E-002	2.1131E-001	2.1131E-002

12. PA Unanalyzed Nuclides with a half life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	3.5209E-008	7.1600E+005	9.8339E-010
Cd-113	A	NRF	3	5.5915E-022	7.7000E+015	1.5589E-023
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	2.9050E-008
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	3.4634E-008
H-3	S	NRF	3	1.3876E-009	1.2300E+001	3.8130E-008
Lu-173	A	NRF	3	7.1504E-012	1.3700E+000	1.9938E-013
Lu-174	A	NRF	3	2.1292E-008	3.3000E+000	5.9363E-010
Mn-53	A	NRF	3	3.8230E-008	3.7400E+006	1.0659E-009
Ra-228	S	NRF	3	2.9791E-013	5.7400E+000	8.3000E-015
Re-186m	A	NRF	3	1.0091E-008	2.0000E+005	2.8136E-010
Sm-147	S	NRF	3	2.8598E-016	1.0600E+011	8.0006E-018
Ta-179	A	NRF	3	9.7500E-011	1.8200E+000	2.7236E-012
Th-228	S	NRF	3	3.9867E-009	1.9100E+000	1.1115E-010
Th-229	S	NRF	3	1.7722E-012	7.8900E+003	4.9412E-014
Th-230	S	NRF	3	1.9204E-013	7.5400E+004	5.3542E-015
Tl-204	A	NRF	3	7.6263E-009	3.7700E+000	2.1260E-010

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	1.4049E-008	A	Yes
Nd-144	3.8738E-027	S	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-106.

PA Check 9

Waste canister ECF-01-21-106 contains 11 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Of the 11 radionuclides, 9 (Ac-227, Cm-245, Cm-246, Hf-178m, Pt-193, Pu-238, Ra-226, Th-232, and U-236) are considered "non-key" radionuclides because they were screened out of the all-pathways dose calculation during preparation of the PA. The cumulative inventories of these radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened out during preparation of the PA. The two key radionuclides (Np-237, and U-234) are evaluated under PA Check 10 (see below). Radionuclides that were flagged by PA Checks 9 and 10 that are not in canister ECF-01-21-106 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0) were evaluated under a previous UDQE and do not need to be evaluated here.

Canister ECF-01-21-106 contains nine non-key radionuclides that exceed the PA base case inventory. Six (Cm-245, Cm-246, Hf-178m, Pt-193, Ra-226, and Th-232) were screened during the Phase II PA screening, and 3 (Ac-227, Pu-238 and U-236) were screened during Phase III PA screening. Table 1 shows that the new cumulative inventories of the nine non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-106) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-106 (column 3) and the total PA base case inventory (column 4) are conservatively summed together for each non-key radionuclide, the totals (column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the non-key radionuclides in ECF-01-21-106 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Radionuclides Screened During PA Phase II Screening							
Non-Key Radionuclide	ECF-01-21-106 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-106) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-106 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-106 as % of Max Allowable Phase II Screening Inventory
Cm-245	8.65E-11	2.84E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	3.46E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Hf-178m	3.11E-07	5.46E-06	4.01E-08	5.50E-06	9.25E+04	4.32E-06	127.16%
Pt-193	7.77E-09	9.57E-05	6.64E-04	7.60E-04	2.92E+02	1.37E-03	55.5%
Ra-226	1.34E-13	5.57E-11	3.14E-11	8.71E-11	2.96E+05	1.35E-06	0.0064%
Th-232	1.87E-18	3.01E-08	2.48E-07	2.78E-07	3.66E+05	1.09E-06	25.5%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	ECF-01-21-106 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-106) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-106 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-106 as % of Max Allowable Phase III Screening Inventory
Ac-227	1.12E-12	2.98E-07	5.76E-06	6.06E-06	1.00E-40	2.30E+34	2.63E-38%
Pu-238	1.27E-06	1.54E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	3.82E-12	1.68E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory, the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated. According to the evaluation in UDQE-RHLLW-087, it would require 4E+39 Ci of Hf-178m to fail the PA Phase III screening criteria, and more than 30,000 Ci of Hf-178m to cause a significant intruder dose. Based on the cumulative Hf-178m inventory from Table 1 (5.5E-06 Ci), Hf-178m will have no impact on the conclusions of the PA.

PA Check 10

Canister ECF-01-21-106 contains two key radionuclides (Np-237 and U-234) whose cumulative inventory (includes placed + proposed canister) exceeds the PA base-case inventory for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These key radionuclides were not screened out during preparation of the PA and their contributions are included in the RHINO all-pathways dose calculation and other performance measures.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-106. The projected all-pathways dose after disposal of canister ECF-01-21-106 would increase by 0.000000034% for the compliance period and 0.07% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-106 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The increases in other performance measures are also very small with the exception of the intruder dose increase of 14.7% and the air-pathway dose increase of 3.9%. While the increase in the intruder dose is relatively large for one canister, it is still far less than the performance measure. The increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of Np-237 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the total inventory after disposal of canister ECF-01-21-106 is within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-106.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-106 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-106 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-106
All Pathways Dose	Compliance	mrem/yr	1	25	4.56E-14	1.35E-04	3.37E-08%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	5.51E-05	7.88E-02	0.070%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	3.24E-14	9.62E-05	3.36E-08%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	5.05E-04	5.60E-02	0.910%
Ra-226/228	Compliance	pCi/L	0.2	5	6.25E-42	2.18E-32	2.87E-08%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	7.49E-11	2.03E-06	0.00369%
Gross Alpha	Compliance	pCi/L	0.6	15	2.15E-37	4.52E-30	4.70E-06%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	3.41E-10	6.34E-06	0.00538%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	1.77E-14	5.26E-05	3.36E-08%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.57E-05	3.06E-02	0.051%
Uranium	Compliance	ug/L	1.2	30	2.02E-34	8.78E-28	2.31E-05%
Uranium	Post-Compliance	ug/L	15	30	1.66E-08	1.67E-05	0.100%
Intruder	Compliance	mrem/yr	20	100	2.61E-02	2.04E-01	14.7%
Air Pathway	Compliance	mrem/yr	0.4	10	4.31E-06	1.15E-04	3.90%

PA Check 11

Figure 1 shows PA Check 11 was flagged by RHINO because the activated metal (AM) inventory of one radionuclide (Mo-93) in waste canister ECF-01-21-106 exceeds 10% of the base case inventory evaluated in the PA as AM in 55-Ton waste canisters from NRF. This check is only performed for key radionuclides. Mo-93 is a key radionuclide in the PA for the groundwater pathway. If a key radionuclide activity in a waste canister exceeds a 10% threshold activity level for that generator, canister type, and waste stream, the canister is flagged for further review according to the change control process to determine if the radionuclide inventory in the container being evaluated is an anomalous occurrence or indicative of a change in waste generation rates. The canister was also evaluated to determine if the inventory of the radionuclide is within the bounds of the PA.

Table 3 shows the inventory of Mo-93 in canister ECF-01-21-106 exceeds the 10% criteria (10.4%). While this is high for one canister, Table 3 shows that the inventory as a percentage of the total 20-year base case inventory of AM for all generators is low (0.086%, see Column 7). Therefore, the inventory of the radionuclide as AM in canister ECF-01-21-106 is well within the bounds of the PA.

Table 3. Radionuclide inventories in canister ECF-01-21-106 that exceed the 10% criteria for AM in NRF 55-Ton canisters compared to PA 20-year base-case inventories of AM for all generators and canisters.

1	2	3	4	5	6	7
Nuclide	Waste Form[a]	Canister ECF-01-21-106 AM Inventory (Ci)	PA 20-yr Base Case Inventory for SC in NRF 55-Ton Canisters (Ci)	Canister ECF-01-21-106 Inventory as % of PA 20-yr Base Case Inventory for AM in NRF 55-Ton Canisters (Col 3/Col 4)[b]	PA 20-yr Base Case AM Inventory for RHLLW Facility (Ci)	Canister ECF-01-21-106 Inventory as % of PA 20-yr Base Case SC Inventory for RHLLW Facility (Col 3/Col 6)
Mo-93	AM	2.20E-02	2.11E-01	10.4%	2.55E+01	0.086%

a. AM = activated metals
b. Radionuclide flagged by RHINO because percentage exceeds 10%.

To determine if the inventory of the key radionuclide is anomalous compared to the inventory of previously placed canisters, Table 4 compares the Mo-93 inventory in canister ECF-01-21-106 to the total inventory of Mo-93 in all previously emplaced canisters. Because the percentage in Column 5 is high (63%), the inventory in canister ECF-01-21-106 seems anomalous compared to other 55-Ton canisters previously placed at the facility. Continued tracking is recommended to see if this continues to be the case.

Table 4. Radionuclide inventory in canister ECF-01-21-106 that exceed the 10% criteria for compared to total inventory of placed canisters regardless of waste form and generator.

1	2	3	4	5
Nuclide	Waste Form	Canister Inventory ECF-01-21-106 (Ci)	Nuclide Inventory of Previously Placed Canisters (Ci)	Canister ECF-01-21-106 Inventory as % of Previously Placed NRF 55-Ton Canisters as AM (Col 3/Col 4)
Mo-93	AM	2.20E-02	5.92E-02	37%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-106 contains 16 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (surface contamination and activated metals) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these 16 radionuclides when compared to the total canister inventory (3587 Ci) are much less than 1% (see Table 5, column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC[1]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Column 6 shows that the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventories (column 2 ÷ column 5) with the exception of Tl-204. The total PA base case inventory of Tl-204 is relatively small at 1.10E-22 Ci due to infrequent occurrence of this radionuclide. However, much more than the base case is reported in canister ECF-01-21-106 which warranted further exploration of its impacts to the overall waste stream. It was determined that the sum of the total base case, previously emplaced waste, and canister ECF 01-21-106 inventories of Tl-204 to be nearly 10,000 times smaller than the maximum allowable inventory to be screened out through PA Phase II screening. This confirms that the unanalyzed radionuclides in canister ECF-01-21-106 will not impact the PA.

Table 5 shows that nine of the 16 radionuclides were reported in other waste streams (column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (column 2 ÷ column 5). This confirms that the nine unanalyzed radionuclides in canister ECF-01-21-106 will not impact the PA.

Table 5. Unanalyzed radionuclides in waste canister ECF-01-21-106 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA
Al-26	3.53E-08	A	9.84E-10%	NA	NA	NA
Cd-113	5.59E-22	A	1.55E-23%	NA	NA	NA
Eu-152	1.04E-06	S	2.91E-08%	4.14E+00	2.52E-05%	III
Eu-154	1.24E-06	S	3.46E-08%	1.56E+01	7.96E-06%	III
H-3	1.37E-06	S	3.81E-08%	1.99E+03	6.87E-08%	Retained
Lu-173	7.15E-12	A	1.99E-13%	NA	NA	NA
Lu-174	2.13E-08	A	5.93E-10%	NA	NA	NA
Mn-53	3.82E-08	A	1.06E-09%	NA	NA	NA
Ra-228	2.98E-13	S	8.31E-15%	2.28E-07	0.000131%	II
Re-186m	1.01E-08	A	2.81E-10%	NA	NA	NA
Sm-147	2.87E-16	S	8.00E-18%	1.38E-10	0.000208%	II
Ta-179	9.79E-11	A	2.73E-12%	NA	NA	NA
Th-228	3.99E-09	S	1.11E-10%	2.02E-04	0.00197%	III
Th-229	1.77E-12	S	4.94E-14%	5.35E-08	0.00331%	II
Th-230	1.92E-13	S	5.35E-15%	4.93E-08	0.000390%	II
Tl-204	7.63E-09	A	2.12E-10%	1.10E-22	6.93E15%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 3587 Ci (from RHINO).
NA = Not Applicable. Not included in any base case PA waste streams.

Seven of the 16 unanalyzed radionuclides were not reported in any other PA waste streama and should be further evaluated. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6).

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories on an individual and cumulative basis.

1	2	3	4	5	6	7	8
Radionuclid e	Canister Inventory (Ci) of ECF-01-21-106	Inventory of All Previously Placed Canisters (Ci)	Sum of New and Previously Placed Canisters (Ci)	Phase II Screening Factor (mrem/Ci)	Maximum Phase II Screening Inventory (Ci/yr)	Canister Inventory as % of Allowable Phase II Screening Inventory	Sum of New and Previously Placed Canisters as % of Max. Allowable Phase II Screening Inventory'
Al-26	3.53E-08	4.66E-08	8.19E-08	1.11E+05	3.60E-06	0.98%	2.27%
Cd-113	5.59E-22	8.64E-22	1.42E-21	2.07E+05	1.93E-06	2.90E-14%	7.37E-14%

[1] Although the H-3 inventory is less than 1% of the canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact will be included in RHINO calculations and H-3 does not need to be evaluated here.

Lu-173	7.15E-12	1.41E-05	1.41E-05	5.55E+02	7.21E-04	9.92E-07%	1.96%
Lu-174	2.13E-08	3.86E-06	3.88E-06	1.22E+03	3.28E-04	0.0065%	1.19%
Mn-53	3.82E-08	4.94E-08	8.76E-08	1.67E+02	2.40E-03	0.0016%	0.0036%
Re-186m	1.01E-08	3.15E-08	4.16E-08	1.37E+04	2.92E-05	0.035%	0.14%
Ta-179	9.79E-11	2.89E-05	2.89E-05	1.89E+02	2.12E-03	4.62E-06%	1.36%

The maximum PA Phase II screening inventory (Column 6) is calculated using Equation 1. All of the values in column 7, percent canister inventory of maximum allowable Phase II screening inventory, and column 8, sum of new and previously placed canister inventory as a percentage of maximum allowable Phase II screening inventory are very small. As these and other unanalyzed radionuclides continue to appear in later waste canisters, the same calculation will continue to be performed on a cumulative basis by canister inventory and cumulative radionuclide inventory.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-106 contains two non-system radionuclides (Nb-91 and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 4 shows radionuclides Nb-91 and Nd-144 are listed as activated metal and surface contamination, respectively, in canister ECF-01-21-106. The long half-life coupled with the very small inventory (< 1E-26 Ci) indicate Nd-144 will not have an impact on the PA.

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The current inventory of Nb-91 is well below 9E+16 Ci.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister ECF-01-21-106 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 4. Non-system radionuclides in waste canister ECF-01-21-106.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nb-91	1.48E-05	AM	680
Nd-144	3.67E-27	SC	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-106 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

ECAR-2073, 2018, "Inadvertent Intruder Analysis for the INL Remote-Handled Low-Level Waste Disposal Facility Performance Assessment," Revision 1, Idaho National Laboratory, January 2018.

INL, 2018, "Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC," INL/EXT-18-45184, Idaho National Laboratory, June 2018.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

UDQE-RHLLW-087, 2024, "Canister ECF-01-21-103 from NRF flagged by RHINO during PA checks," February 2024.

Yu, C., A. J. Zielen, J.-J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H. Peterson, 2016, *RESRAD Version 7.2*, ANL/EAD-4, Argonne National Laboratory.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Originator/FDS	04/17/2024
A. R. Prather System Engineer/SE	A. R. Prather System Engineer/SE	4/17/24
A. Jeff Sondrup PA/CA SME	Jeff Sondrup PA/CA SME	04/16/2024
Paul A. Velasquez Waste Management/WMP	Paul A. Velasquez Waste Management/WMP	04/16/2024
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Nuclear Facility Manger/NFM	04/16/2024

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-093

Subject: NRF Request for Exception to Reswipe Canister ECF-01-21-106

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

In 2022, Naval Reactors Facility (NRF) requested and was granted a permanent exception to limits of removable surface contamination on the exterior of waste canisters shipped to the current Remote-Handled Low-Level Waste (RHLLW) Disposal Facility as specified in the waste acceptance criteria (WAC), PLN-5446. A UDQE (UDQE-RHLLW-063) and a Special Analysis (SA) (INL/RPT-22-68668) were performed to address the request and the WAC was updated to include new limits for NRF waste canisters (see Section 2.6.1 of PLN-5546). As a condition of receiving approval for the exception, NRF committed to swipe the lid (top) of each canister prior to loading the canister into the cask, and analyze the swipe to confirm exterior contamination meets WAC requirements. Additionally, NRF agreed each canister must be loaded into the cask within 2 weeks from the date of the original swipe or the swipe/analysis procedure must be performed again prior to loading.

Waste canister ECF-01-21-106 was cleaned and the lid was swiped on April 16, 2024. The plan was to load the canister into the cask a few days later, but loading was delayed due to an issue with a load cell on the hoist. The hoist has since been repaired and plans are to load the canister on May 2, 2024 which is 2 days beyond the two-week window. NRF has requested a one-time exception for canister ECF-01-21-106 to exceed by two days the two-week requirement to load the canister, without having to reswipe, and reanalyze prior to loading. NRF supplied the following information in support of their request:

- The original swipe results were all less than detectable (<1000 dpm beta-gamma and <20 dpm alpha) surveys which gives a large margin to the limits in the WAC,
- The canister is currently in the loading stand and the cask is installed above it, preventing any movement of the canister, and
- There is no work expected in the same area that could contribute to an increase in contamination on the canister.

The purpose of this UDQE is to evaluate this request for impacts to the approved PA or SA.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☒ No ☐

Comments: A process for demonstrating compliance with the canister exterior contamination limits in the RHLLW WAC was written into NRF procedures and was part of the generator certification. NRF is requesting an exception to this requirement. Any deviation from this process must be evaluated to establish WAC can still be met or there is no impact to the PA.

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	*Jonathan Jacobson*	05/02/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	*Timothy Arsenault*	05/02/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

In evaluating NRF's request for a one-time exception to the requirement that canisters must be loaded within two-weeks of being cleaned and swiped, the following was considered:

- Lid swipes of waste canister ECF-01-21-106 on April 16, 2024 showed less than detectable levels (<1000 dpm beta-gamma and <20 dpm alpha). The two-week window would only be exceeded by two days. In this case it is very unlikely that the contamination would be significantly greater than indicated by the swipes of the lid taken on April 16, 2024. This is supported by data from waste canister ECF-01-21-111 which was on the loading stand for one month. The lid of canister ECF-01-21-111 was originally swiped on March 7, 2024 and the canister sat on the loading stand until April 7, 2024 when it was swiped again. The results of both swipes was less than detectable levels (<1000 dpm beta-gamma and <20 dpm alpha). Additionally, swipes are taken from the lids of the canisters where the contamination is expected to be the highest. Based on this, the majority of the surface area of the containers is expected to be less than the lid swipe results.

- NRF has affirmed there has not been nor will there be any activity in the water pool that would result in increased contamination on the canister during the 16 days canister ECF-01-21-106 is expected to be on the loading stand.

Based on this information, it is unlikely the exterior contamination on canister ECF-01-21-106 is greater than WAC limits, and NRF's request for a one-time exception is reasonable and acceptable provided the following conditions are met:

- Canister ECF-01-21-106 has not been moved from the loading stand between the time the first set of swipes were taken (4-16-24) and the time it will be loaded into the cask.
- Canister ECF-01-21-106 is loaded into the cask no later than 5-2-24 which would exceed the two-week window by 2 days.
- The results from the first set of swipes on canister ECF-01-21-106 performed April 16, 2024 were all less than detectable (<1000 dpm beta-gamma and <20 dpm alpha).
- There has not been, nor will there be, any work or activity in the water pool between 4-16-24 and 5-2-24 that would contribute to an increase in contamination on canister ECF-01-21-106.
- NRF provide BEA a copy of their own paperwork no later than noon on 5-6-24 indicating this is a one-time exception to their own procedure requiring waste canisters to be loaded within two-weeks after the initial set of swipes.

NRF has confirmed through email (Keith Veldkamp to Tim Arsenault, 4-24-24; Dustin Esterholdt to Tim Arsenault, 4-25-24) and phone call (Keith Veldkamp to Jeff Sondrup, 5-1-24) that these conditions have been or will be met. All emails and paperwork provided to BEA by NRF will be added to the acceptance documents on RHINO.

Print/Type Name	Signature	Date
Jonathan Jacobson	Jonathan Jacobson	05/02/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	5/2/24
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	05/02/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	05/02/2023
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	5/7/24
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

____

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Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-094

Subject: Canister ECF-01-21-104 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-104 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-104 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA check 9 was flagged by RHINO because the cumulative inventories of 21 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Cs-137, Hf-178m, Ir-192m, Kr-85, La-137, Np-237, Pt-193, Pu-238, Pu-240, Ra-226, Ra-228, Rb-87, Sr-90, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Sixteen of the 21 radionuclides flagged in PA check 9 and present in ECF-01-21-104 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 16 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA check 10 was flagged by RHINO because the cumulative inventory of five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these five key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
This flag was checked by RHINO because the canister inventory of six radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90, and U-234) exceed the 10% threshold level of the PA base-case inventory for this generator, waste form and canister type. A threshold of 10% was selected by considering the total number of waste disposal vaults, the variance in expected container radionuclide inventory levels, and other pathway-specific considerations presented in INL (2018). According to INL (2018), if a single container exceeds 10% of the radionuclide-specific base-case inventory modeled in the PA for a specific generator, waste form, and canister type, the container will be flagged for further review to determine if the canister inventory is an anomalous occurrence or indicative of a change in waste generation rates. This check is performed for the 18 key radionuclides listed in Table 18 of INL (2018) that were analyzed in the PA for the groundwater, air and intruder pathways.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because 19 unanalyzed radionuclides with half-lives greater than 1 year, and three non-system/non-exempt radionuclides were identified by RHINO in waste canister ECF-01-21-104. These must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

   Yes ☒ No ☐

Comments: Canister ECF-01-21-104 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	05/20/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	5/21/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA checks 9, 10, 11 and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-104. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-01-21-104

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	5/2/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	5/2/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	5/2/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	5/2/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	5/2/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	5/2/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	5/2/2024
	Yes	Gross Alpha	6.3706E-006	7.5	pCi/L	Post Compliance	5/2/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	5/2/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	5/2/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	5/2/2024
	Yes	Uranium	1.6901E-005	15	ug/L	Post Compliance	5/2/2024
7	Yes	Intruder	1.8584E-001	20	mrem/yr	Compliance	5/2/2024
8	Yes	Air Pathway	1.3587E-004	0.4	mrem/yr	Compliance	5/2/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/2/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/2/2024
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/2/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check.	-			Compliance	5/2/2024
13	Yes	Canister Action Levels Check	-			Compliance	5/2/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: NRF

Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	2.9789E-007	2.0884E-007	1.7784E-013
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	7.3910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8414E-007	6.9997E-008	1.5742E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1603E-007	3.5211E-008	6.2945E-011
Cs-137 [Details]	3.0100E+001	S	55-Ton Cask	NRF	3	West	8.0335E-002	6.9179E-002	2.8720E-002
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.3315E-006	4.0123E-008	1.8344E-007
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.7566E-006	7.6070E-007	
Kr-85 [Details]	1.0700E+001	S	55-Ton Cask	NRF	3	West	3.8235E-003	3.4951E-003	1.2132E-003
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.5365E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	7.7222E-007	3.3543E-009	1.7486E-007
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.5723E-005	8.0353E-005	2.4909E-014
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	3.8413E-003	3.8088E-004	2.2953E-003
Pu-240 [Details]	6.5600E+003	S	55-Ton Cask	NRF	3	West	6.2400E-005	6.2158E-005	2.9136E-005
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5600E-011	3.0840E-012	2.1632E-014
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.0046E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	1.6443E-007	1.0867E-007	3.6000E-014
Sr-90 [Details]	2.8900E+001	S	55-Ton Cask	NRF	3	West	8.1893E-002	6.9832E-002	1.3126E-002
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8398E-008	2.5084E-009	2.1430E-017
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.0129E-008	1.5922E-008	5.8734E-020
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	6.2629E-006	4.7761E-007	1.1022E-006
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	2.1770E-006	5.3927E-009	4.9319E-007

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

11. Administrative 10% Canister Inventory Check (Canister Specific)

Nuclide	Form	Generator	Vault	Array	Amount (Ci)	PA Inv (Ci)	Threshold (Ci)
Cs-137	S	NRF	55-Ton Cask	3	2.8720E-002	6.9179E-002	6.9179E-003
Np-237	S	NRF	55-Ton Cask	3	1.7486E-007	3.3543E-009	3.3543E-010
Pu-239	S	NRF	55-Ton Cask	3	1.4548E-005	7.0409E-005	7.0409E-006
Pu-240	S	NRF	55-Ton Cask	3	2.9136E-005	6.2158E-005	6.2158E-006
Sr-90	S	NRF	55-Ton Cask	3	1.3126E-002	6.9832E-002	6.9832E-003
U-234	S	NRF	55-Ton Cask	3	1.1022E-006	4.7761E-007	4.7761E-008

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	5.0770E-010	7.1600E+005	4.5292E-010
Cd-113	A	NRF	3	8.5152E-024	7.7000E+015	7.5965E-024
Cd-113m	S	NRF	3	1.3380E-006	1.4100E+001	1.1937E-006
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	9.3081E-007
Eu-154	S	NRF	3	5.1407E-004	8.5900E+000	4.5860E-004
Eu-155	S	NRF	3	8.6453E-005	4.7500E+000	7.7126E-005
H-3	S	NRF	3	2.9086E-006	1.2300E+001	2.5948E-006
Lu-173	A	NRF	3	7.5985E-007	1.3700E+000	6.7787E-007
Lu-174	A	NRF	3	1.5630E-007	3.3000E+000	1.3944E-007
Mn-53	A	NRF	3	2.9260E-010	3.7400E+006	2.6103E-010
Pb-210	A	NRF	3	1.8650E-015	2.2200E+001	1.6638E-015
Ra-228	S	NRF	3	3.0171E-013	5.7400E+000	2.6916E-013
Re-186m	A	NRF	3	6.0049E-010	2.0000E+005	5.3570E-010
Sm-147	S	NRF	3	1.7597E-015	1.0600E+011	1.5698E-015
Sm-151	S	NRF	3	8.3022E-005	9.0000E+001	7.4065E-005
Ta-179	A	NRF	3	3.2132E-006	1.8200E+000	2.8665E-006
Th-228	S	NRF	3	8.8183E-009	1.9100E+000	7.8669E-009
Th-229	S	NRF	3	9.4406E-013	7.8900E+003	8.4220E-013
Th-230	S	NRF	3	1.0260E-013	7.5400E+004	9.1530E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	3.4823E-006	A	Yes
Nb-91m	4.3855E-015	A	Yes
Nd-144	2.1328E-024	S	Yes
Nd-144	1.0436E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-104.

PA Check 9

The RHINO acceptance check for waste canister ECF-01-21-104 identified 21 radionuclides whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). However, four radionuclides that were flagged by PA Checks 9 and 10 are not in canister ECF-01-21-104 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0), and because they were evaluated under a previous UDQE, they do not need to be evaluated here. Of the remaining 17 radionuclides, 13 (Ac-227, Cm-245, Cm-246, Cs-137, Hf-178m, Pt-193, Pu-238, Ra-226, Rb-87, Sr-90, Th-229, Th-232, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the all-pathways dose calculation during preparation of the PA. Kr-85 was screened during Phase I for the groundwater pathway because even though it has a half-life greater than 1 year, it is a gas and will not contribute to the groundwater pathway dose or the intruder dose. The Kr-85 impact on the air pathway is evaluated below.

Groundwater Pathway

The cumulative inventories of 13 non-key groundwater pathway radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. The three key radionuclides for the groundwater pathway

(Np-237, Pu-240, and U-234) and the two key radionuclides for the intruder pathway (Cs-137 and Sr-90) are evaluated under PA Check 10 (see below).

Eight of the 13 non-key groundwater pathway radionuclides (Cm-245, Cm-246, Hf-178m, Pt-193, Ra-226, Rb-87, Th-229 and Th-232) were screened during the Phase II PA groundwater pathway screening, and five (Ac-227, Cs-137, Pu-238, Sr-90 and U-236) were screened during Phase III PA groundwater pathway screening. Table 1 shows that the new cumulative inventories of the 13 non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-104) was added to the total PA base case inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE/ID-11421, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x\ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE/ID-11421, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-104 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the non-key radionuclides in ECF-01-21-104 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory (see Table 1, Column 8), the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated. According to the evaluation in UDQE-RHLLW-087, it would require 4E+39 Ci of Hf-178m to fail the PA Phase III screening criteria, and more than 30,000 Ci of Hf-178m to cause a significant intruder dose. Based on the cumulative Hf-178m inventory from Table 1 (5.33E-06 Ci), Hf-178m will have no impact on the conclusions of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	ECF-01-21-104 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-104) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-104 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-104 as % of Max Allowable Phase II Screening Inventory
Cm-245	1.57E-10	2.84E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	6.29E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Hf-178m	1.83E-07	5.33E-06	4.01E-08	5.37E-06	9.25E+04	4.32E-06	**124%**
Pt-193	2.49E-14	9.57E-05	6.64E-04	7.60E-04	2.92E+02	1.37E-03	55.5%
Ra-226	2.16E-14	5.56E-11	3.14E-11	8.70E-11	2.96E+05	1.35E-06	0.00644%
Rb-87	3.60E-14	1.64E-07	1.28E-06	1.44E-06	4.44E+03	9.01E-05	1.60%
Th-229	2.14E-17	2.84E-08	5.35E-08	8.19E-08	1.18E+05	3.38E-06	2.42%
Th-232	5.87E-20	3.01E-08	2.48E-07	2.78E-07	3.66E+05	1.09E-06	25.5%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	ECF-01-21-104 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + ECF-01-21-104) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of ECF-01-21-104 + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of ECF-01-21-104 as % of Max Allowable Phase III Screening Inventory
Ac-227	1.78E-13	2.98E-07	5.76E-06	6.06E-06	1.00E-40	2.30E+34	2.63E-42%
Cs-137	2.87E-02	8.03E-02	9.45E+02	9.45E+02	1.00E-40	3.78E+42	2.50E-42%
Pu-238	2.30E-03	3.84E-03	3.68E-01	3.72E-01	2.57E-02	5.73E+00	6.49%
Sr-90	1.31E-02	8.19E-02	6.73E+02	6.73E+02	1.00E-40	2.69E+42	2.50E-42%
U-236	4.93E-07	2.18E-06	5.88E-05	6.10E-05	1.04E-02	2.26E-03	2.70%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Air Pathway

As previously stated, Kr-85 was screened during Phase II of the air pathway screening. Here, the Kr-85 inventory was evaluated to determine if the new cumulative inventory would still be screened from the air pathway. Air pathway screening is based on the total PA base case inventory of all generators. The total amount of Kr-85 evaluated in the PA is 50.4 Ci. Canister ECF-01-21-104 contains 1.21E-3 Ci of Kr-85 and the cumulative amount thus far in all vault arrays is 3.82E-03 Ci (see Figure 1), or 0.008% of the PA base case inventory. This small additional amount is insignificant compared to the PA base case inventory and would not result in Kr-85 being retained as a key air pathway radionuclide. Therefore, the Kr-85 inventory in canister ECF-01-21-104 is within the bounds of the PA.

PA Check 10

Canister ECF-01-21-104 contains five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) whose cumulative inventories (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). Radionuclides Np-137, Pu-240 and U-234 are key radionuclides for the groundwater pathway and their contributions are included in the RHINO all-pathways dose calculation. Radionuclides Cs-137 and Sr-90 are key radionuclides for the intruder pathway and their contributions are included in the RHINO intruder pathway dose calculation.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-104. The projected all-pathways dose after disposal of canister ECF-01-21-104 would increase by 0.000000097% for the compliance period and 0.08% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of ECF-01-21-104 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of canister ECF-01-21-104 would increase by 0.75%. This is a small increase and the total intruder dose of 0.186 mrem/yr is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario). The increases in other performance measures are also very small with the exception of the air-pathway dose increase of 5.77%. While the increase in the air pathway dose is relatively large for one canister, the projected dose is still far less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of key radionuclides Cs-137, Np-237, Pu-240, Sr-90 and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-01-21-104 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of canister ECF-01-21-104.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister ECF-01-21-104 (mrem/yr)	Placed Canisters + Proposed Canister ECF-01-21-104 (mrem/yr)	% Increase in All-Pathways Dose After Placement of ECF-01-21-104
All Pathways Dose	Compliance	mrem/yr	1	25	1.31E-13	1.35E-04	9.70E-08%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	6.09E-05	7.88E-02	0.08%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	9.33E-14	9.62E-05	9.70E-08%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	2.10E-05	5.60E-02	0.038%
Ra-226/228	Compliance	pCi/L	0.2	5	3.72E-39	2.19E-32	1.70E-05%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.57E-08	2.04E-06	0.77%
Gross Alpha	Compliance	pCi/L	0.6	15	1.06E-36	4.55E-30	2.32E-05%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	3.87E-07	6.37E-06	6.47%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	5.10E-14	5.26E-05	9.70E-08%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.77E-05	3.06E-02	0.058%
Uranium	Compliance	ug/L	1.2	30	3.50E-34	8.88E-28	3.94E-08%
Uranium	Post-Compliance	ug/L	15	30	1.91E-08	1.69E-05	0.11%
Intruder	Compliance	mrem/yr	20	100	1.39E-03	1.86E-01	0.75%
Air Pathway	Compliance	mrem/yr	0.4	10	7.41E-06	1.36E-04	5.77%

PA Check 11

Figure 1 shows PA Check 11 was flagged by RHINO because the surface contamination (SC) inventory of six key radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90, and U-234) in waste canister ECF-01-21-104 exceeds 10% of the base case inventory evaluated in the PA as SC in 55-Ton waste canisters from NRF. This check is only performed for key radionuclides. Np-237, Pu-239, Pu-240, and U-234 are key radionuclides in the PA for the groundwater pathway and Cs-137 and Sr-90 are key radionuclides for the intruder pathway. If a key radionuclide activity in a waste canister exceeds a 10% threshold activity level for that generator, canister type, and waste stream, the canister is flagged for further review according to the change control process to determine if the radionuclide inventory in the container being evaluated is an anomalous occurrence or indicative of a change in waste generation rates. The canister was also evaluated to determine if the inventory of each radionuclide is within the bounds of the PA (see PA Check 10).

Table 3 shows the inventory of Cs-137, Np-237, Pu-239, Pu-240, Sr-90, and U-234 in canister ECF-01-21-104 exceed the 10% criteria to varying degrees (see Table 3, Column 5). While each of these are high for one canister, Table 3 shows that the inventory as a percentage of the total 20-year base case inventory of SC for all generators is low (see Column 7). Therefore, the inventory of each radionuclide as SC in canister ECF-01-21-104 is well within the bounds of the PA.

Table 3. Radionuclide inventories in canister ECF-01-21-104 that exceed the 10% criteria for SC in NRF 55-Ton canisters compared to PA 20-year base-case inventories of SC for all generators and canisters.

1	2	3	4	5	6	7
Nuclide	Waste Form[a]	Canister ECF-01-21-104 SC Inventory (Ci)	PA 20-yr Base Case Inventory for SC in NRF 55-Ton Canisters (Ci)	Canister ECF-01-21-104 Inventory as % of PA 20-yr Base Case Inventory for SC in NRF 55-Ton Canisters (Col 3/Col 4)[b]	PA 20-yr Base Case SC Inventory for RHLLW Facility (Ci)	Canister ECF-01-21-104 Inventory as % of PA 20-yr Base Case SC Inventory for RHLLW Facility (Col 3/Col 6)
Cs-137	SC	2.87E-02	6.92E-02	41.5%	9.18E+02	0.0031%
Np-237	SC	1.75E-07	3.35E-09	5213%	5.82E-04	0.030%
Pu-239	SC	1.45E-05	7.04E-05	20.7%	3.15E-01	0.0046%
Pu-240	SC	2.91E-05	6.22E-05	46.9%	2.28E-03	1.28%
Sr-90	SC	1.31E-02	6.98E-02	18.8%	6.42E+02	0.0020%
U-234	SC	1.10E-06	4.78E-07	230%	1.25E-04	0.882%

a. SC = surface contamination
b. Radionuclide flagged by RHINO because percentage exceeds 10%.

To determine if the inventories of the key radionuclides are anomalous compared to the inventories of previously placed canisters, Table 4 compares the inventories in canister ECF-01-21-104 to the total inventories in all 14 previously emplaced NRF 55-Ton canisters. If each canister was similar, the inventories in canister ECF-01-21-104 would be approximately 1/14th (7%) of the total inventory of each radionuclide. The results in Column 5 show the percentages in canister ECF-01-21-104 are much higher than 7% indicating the inventories in this canister are anomalous. Further investigation revealed that two other 55-Ton canisters (ECF-05-18-118 and ECF-05-18-120) have much higher inventories than the others and the percentages in ECF-01-21-104 are similar to these two canisters (see Columns 6 and 7). These three canisters have significantly greater inventories of these five key radionuclides than other canisters placed at the facility. Therefore, the inventories of key radionuclides in canister ECF-01-21-104 are somewhat anomalous compared to all canisters, but similar to two other canisters. Continued tracking is recommended to see if this continues to be the case.

Table 4. Inventory of key radionuclides in canister ECF-01-21-104 that exceed the 10% criteria for compared to total inventory of placed canisters regardless of waste form and generator. Inventory percentages in ECF-01-21-104 are also compared to two other canisters with high percentages.

1	2	3	4	5	6	7
Nuclide	Waste Form	Canister Inventory ECF-01-21-104 (Ci)	SC Inventory of Previously Placed Canisters (Ci)	Canister ECF-01-21-104 SC Inventory as % of SC in Previously Placed NRF 55-Ton Canisters (Col 3/Col 4)	Canister ECF-05-18-118 SC Inventory as % of SC in Previously Placed NRF 55-Ton Canisters	Canister ECF-05-18-120 SC Inventory as % of SC in Previously Placed NRF 55-Ton Canisters
Cs-137	SC	2.87E-02	5.16E-02	56%	53%	41%
Np-237	SC	1.75E-07	5.97E-07	29%	56%	43%
Pu-239	SC	1.45E-05	1.97E-05	74%	45%	34%
Pu-240	SC	2.91E-05	3.33E-05	88%	52%	40%
Sr-90	SC	1.31E-02	6.88E-02	19%	54%	42%
U-234	SC	1.10E-06	5.16E-06	21%	56%	43%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-104 contains 19 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (surface contamination and activated metals) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5546) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these 19 radionuclides when compared to the total canister inventory (112.1 Ci) are much less than 1% (see Table 5, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[1]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Column 6 shows that the canister ECF-01-21-104 inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventories (Column 2 ÷ Column 5).

Table 5 shows that 12 of the 19 radionuclides were reported in other waste streams (Column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory (Column 2 ÷ Column 5). This is evidence that the 12 unanalyzed radionuclides in canister ECF-01-21-104 will not impact the PA.

Table 5. Unanalyzed radionuclides in waste canister ECF-01-21-104 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Al-26	5.08E-10	AM	4.53E-10%	N/A	N/A	N/A
Cd-113	8.52E-24	AM	7.60E-24%	N/A	N/A	N/A
Cd-113m	1.60E-05	AM	1.43E-05%	9.80E-01	0.164%	III
Eu-152	1.04E-06	SC	9.31E-07%	4.14E+00	0.000025%	III
Eu-154	5.14E-04	SC	4.59E-04%	1.56E+01	0.0033%	III
Eu-155	8.65E-05	SC	7.71E-05%	1.65E+00	0.0052%	III
H-3	2.91E-06	SC	2.59E-06%	1.99E+03	0.000015%	Retained
Lu-173	7.60E-07	AM	6.78E-07%	N/A	N/A	N/A
Lu-174	1.56E-07	AM	1.39E-07%	N/A	N/A	N/A
Mn-53	2.93E-10	AM	2.61E-10%	N/A	N/A	N/A
Pb-210	1.87E-15	AM	1.66E-15%	2.89E-12	0.065%	II
Ra-228	3.02E-13	SC	2.69E-13%	2.28E-07	0.00013%	II
Re-186m	6.00E-10	AM	5.36E-10%	N/A	N/A	N/A
Sm-147	1.76E-15	SC	1.57E-15%	1.38E-10	0.0013%	II
Sm-151	8.30E-05	SC	7.41E-05%	5.27E+01	0.00016%	III
Ta-179	3.21E-06	AM	2.87E-06%	N/A	N/A	N/A
Th-228	8.82E-09	SC	7.87E-09%	2.02E-04	0.0044%	III
Th-229	9.44E-13	SC	8.42E-13%	5.35E-08	0.0018%	II
Th-230	1.03E-13	SC	9.15E-14%	4.93E-08	0.00021%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 112.1 Ci (from RHINO).
N/A = Not Applicable. Not included in any base case PA waste streams.

Seven of the 19 unanalyzed radionuclides were not reported in any other PA waste streams and should be further evaluated. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6).

[1] Although the H-3 inventory is less than 1% of the canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact will be included in RHINO calculations and H-3 does not need to be evaluated here.

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories on an individual and cumulative basis.

1	2	3	4	5	6	7	8
Radionuclide	Canister ECF-01-21-104 Inventory (Ci)	Inventory of All Previously Placed Canisters (Ci)	Sum of ECF-01-21-104 and Previously Placed Canisters Inventory (Ci)	Phase II Screening Factor (mrem/Ci)	Maximum Allowable Phase II Screening Inventory (Ci/yr)	Canister ECF-01-21-104 Inventory as % of Maximum Allowable Phase II Screening Inventory	Sum of ECF-01-21-104 and Previously Placed Canisters Inventory as % of Max Allowable Phase II Screening Inventory'
Al-26	5.08E-10	8.91E-08	8.96E-08	1.11E+05	3.60E-06	0.014%	2.49%
Cd-113	8.52E-24	8.69E-22	8.77E-22	2.07E+05	1.93E-06	4.41E-16%	4.54E-14%
Lu-173	7.60E-07	1.41E-05	1.49E-05	5.55E+02	7.21E-04	0.105%	2.06%
Lu-174	1.56E-07	3.86E-06	4.02E-06	1.22E+03	3.28E-04	0.048%	1.23%
Mn-53	2.93E-10	6.99E-08	7.02E-08	1.67E+02	2.40E-03	0.000012%	0.0029%
Re-186m	6.00E-10	3.15E-08	3.21E-08	1.37E+04	2.92E-05	0.0021%	0.110%
Ta-179	3.21E-06	2.89E-05	3.21E-05	1.89E+02	2.12E-03	0.152%	1.52%

The maximum PA Phase II screening inventory in Table 6 Column 6 is calculated using Equation 1. All of the values in Column 7 and Column 8 are very small. As these and other unanalyzed radionuclides appear in future waste canisters, the same calculation will continue to be performed.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-104 contains three non-system radionuclides (Nb-91, Nb-91m, and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 7 shows radionuclides Nb-91 and Nb-91m are listed as activated metal and Nd-144 is listed as both surface contamination and activated metal in canister ECF-01-21-104. The long half-life coupled with the very small inventory (< 1E-22 Ci) indicate Nd-144 will not have an impact on the PA. The inclusion of Nb-91m in waste canister ECF-01-21-104 would not affect the assumptions of the PA due to the very small inventory (3.48E-06 Ci) and short half-life (less than one year).

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The inventory of Nb-91 in canister ECF-01-21-104 is insignificant compared to 9E+16 Ci.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic intruder dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister ECF-01-21-104 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 7. Non-system radionuclides in waste canister ECF-01-21-104.

Radionuclide	Canister Inventory (Ci)	Waste Form[a]	Half-Life (yr)
Nb-91	3.48E-06	AM	680
Nb-91m	4.39E-15	AM	0.167
Nd-144	2.13E-24	SC	2.3E+15
Nd-144	1.04E-23	AM	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-104 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

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PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

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Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	05/20/2024 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	5/21/24 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	05/20/2024 Date
Jacob Yedica Print/Type Name Waste Management/WMP	Jacob Yedica Signature Waste Management/WMP	05/21/2024 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	5/21/2024 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-095

Subject: ATR-5 Canister 814600-15 flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister 814600-15 is an ATR-5 waste canister containing activated metals from the Advanced Test Reactor (ATR) Complex. Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister 814600-15 was flagged by RHINO for the following:

PA Check 12: Waste canister 814600-15 was flagged by RHINO because it contains a radionuclide with a half-life greater than 1 year that was not analyzed in the PA for this particular generator, canister type and waste form. The radionuclide is Co-60 and the waste form is surface contamination.

Radionuclides in a particular waste form from a specific generator, and in a specific canister type that were not considered in the PA fit the definition of a change that must be evaluated before the canister can be accepted according to RH-ADM-5214.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Waste canister 814600-15 was flagged by RHINO while performing PA checks. The flag indicates there is a change from what was considered in the PA that must be evaluated.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	*Jonathan Jacobson*	05/15/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	*Timothy Arsenault*	05/15/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

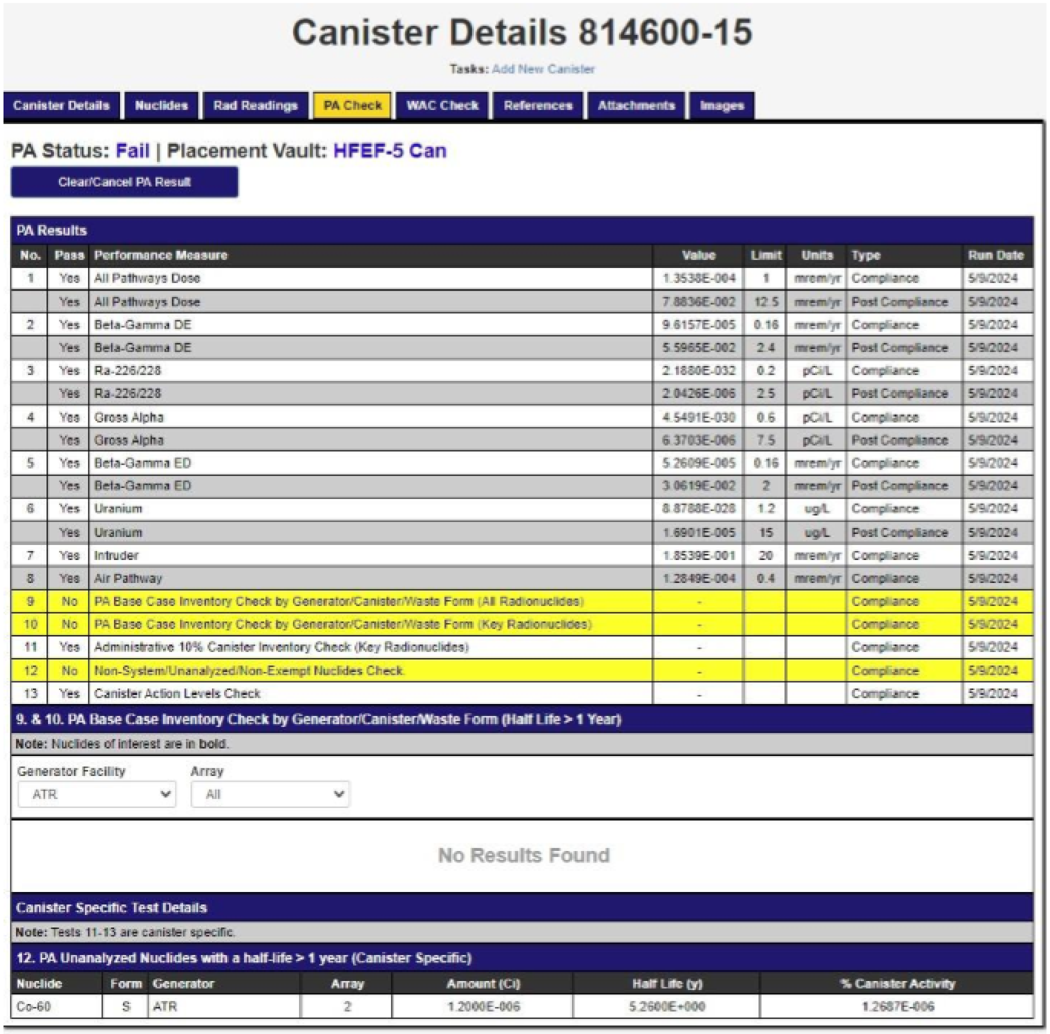
Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Waste canister 814600-15 was flagged by RHINO while performing PA checks as part of the acceptance process for disposal. Figure 1 shows the canister details page from RHINO and the results of the PA checks.



Canister Details 814600-15

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: HFEF-5 Can

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	5/9/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	5/9/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	5/9/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	5/9/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	5/9/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	5/9/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	5/9/2024
	Yes	Gross Alpha	6.3703E-006	7.5	pCi/L	Post Compliance	5/9/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	5/9/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	5/9/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	5/9/2024
	Yes	Uranium	1.6901E-005	15	ug/L	Post Compliance	5/9/2024
7	Yes	Intruder	1.8539E-001	20	mrem/yr	Compliance	5/9/2024
8	Yes	Air Pathway	1.2849E-004	0.4	mrem/yr	Compliance	5/9/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	5/9/2024
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold.

Generator Facility: ATR | Array: All

No Results Found

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Co-60	S	ATR	2	1.2000E-006	5.2600E+000	1.2687E-006

Figure 1. PA Check output screen from RHINO for ATR-5 waste canister 814600-15.

Although Figure 1 shows PA checks 9 and 10 as failed, this is the result of radionuclides from other generators, in other canister types, and waste forms. They were evaluated in previous UDQEs and are not a concern for this evaluation.

PA Check 12: PA check 12 was flagged by RHINO because the canister contains a radionuclide (Co-60) with a half-life greater than 1 year that was not analyzed in the PA for this particular generator (ATR), canister type (ATR-5) and waste form (surface contamination).

During preparation of the PA, the projected radionuclide inventory for ATR-5 waste canisters only included radionuclides in activated metals. No radionuclides were listed as surface contamination. The RHLLW Disposal

Facility was notified by the ATR Canal Cleanout Project in 2021 that residual contamination from ATR canal water activity could be present on the surfaces of the activated metals loaded inside the waste baskets and on the inner and outer surfaces of the baskets. The surface contamination radionuclides and relative abundances were obtained from canal chemistry results from 2020 and 2021. The activities were estimated to be minor (uCi or less for individual canisters) and most of the radionuclides that could be present have half-lives less than one year which are not a concern from a PA standpoint. Based on this information, it was decided that surface contamination would be reported, but canister acceptance would be evaluated on a canister-by-canister basis until a more efficient process is developed.

Because Co-60 is a key radionuclide (for the intruder pathway) the minimum reporting limit is 1E-12 Ci. Although the 1.20E-06 Ci of Co-60 as surface contamination in canister 814600-15 is greater than the reporting limit, it is insignificant compared to the amount of Co-60 reported as surface contamination for all generators combined (734 Ci, see PA [DOE-ID 2018], Table 2-14), and the amount of Co-60 reported for all waste forms from all generators (309,000 Ci, see PA [DOE-ID 2018], Table 2-14). Therefore, the Co-60 as surface contamination in canister 814600-15 is within the bounds of the PA and the canister is acceptable for disposal.

> Note: Co-60 is not a key radionuclide for the groundwater pathway in the PA. The amount of Co-60 acceptable from a groundwater pathway perspective is greater than 1E+40 Ci based on the Phase III screening in the PA. However, Co-60 is a key radionuclide for the intruder pathway. Although Co-60 as surface contamination from ATR was not evaluated in the PA, all Co-60 activity regardless of waste form or generator is included in the intruder pathway dose calculated by RHINO. Nevertheless, the inventory of Co-60 as surface contamination in future ATR-5 canisters could be at least 1E+06 times the amount in canister 816400-15 and still be acceptable based on intruder dose performance objectives.

Summary:

Co-60 as surface contamination in canister 814600-15 is within the bounds of the PA and the canister is acceptable for disposal.

Recommendations:

It is recommended the RHLLW disposal project update Table B-1 of PLN-5446, Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility to include the nine radionuclides (Co-58, Co-60, Cr-51, Hf-175, Hf-181, Mo-99, Na-24, Re-188, and Sb-124) reported as surface contamination on ATR activated metal components and the waste basket. The appropriate table in RHINO should also be updated to include these nine radionuclides. Co-60 is the only one of the nine with a half-life greater than 1 year, and it will continue to be flagged by PA Check 12 (unanalyzed with half-life > 1 year) until the RHINO table is updated.

References:

DOE-ID 2018, "Performance Assessment for the Idaho National Laboratory Remote Handled Low Level Waste Disposal Facility," DOE/ID-11421, Idaho National Laboratory.

PLN-5546, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory.

Jonathan Jacobson	Jonathan Jacobson	05/16/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	5/16/24
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	05/16/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Jacob Yedica	Jacob Yedica	05/16/24
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Jonathan Jacobson	Timothy Arsenault	05/20/2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-096

Subject: Proposed Changes to RHLLW Disposal Facility Monitoring Plan (PLN-5501)

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

It is recommended PLN-5501, "Monitoring Plan for the INL RHLLW Disposal Facility," be updated based on information collected while monitoring the facility during the first four years of operations.

The proposed changes are:

- Increase length of time for baseline data collection phase from 3 to 4 years.
- Revise gross-alpha action level for lysimeter samples during post-baseline monitoring phase from 10 to 20 pCi/L, and add tritium to analyte list.
- Revise lysimeters to be sampled and response actions for the post-baseline monitoring phase.
- Revise schedule/conditions for post-baseline monitoring phase annual lysimeter sampling.
- Revise compliance (aquifer) sampling response actions for exceedance of lysimeter action level.

According to RH-ADM-5214 "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," an Unreviewed Disposal Question Screening (UDQS) is mandatory when revising certain Radioactive Waste Management Basis (RWMB) documents. PLN-5501 is one of the documents that requires a mandatory screening. RH-ADM-5214 defines a "proposed change" as information resulting from research and development, operation activities, or discoveries or information that have the potential to affect the assumptions and/or conclusions of the facility performance assessment (PA) or composite analysis (CA).

The purpose of this screening is to identify the proposed changes and determine if they have the potential to affect the assumptions and/or conclusions of the PA or CA as defined in RH-ADM-5214.

Background

The original PLN-5501 called for a baseline monitoring period to be followed by a surveillance monitoring period. The original length of the baseline period was planned to last three years (FY 2019 through FY 2021). However, a preliminary evaluation of lysimeter data collected during the first three years of operations was performed prior to collection of samples in the spring of FY 2022. This evaluation determined that insufficient data had been collected to determine baseline concentrations for some lysimeters and analytes (see INL 2023, Appendix B, Table B-6). As a result, the baseline period was extended another year, and analyte priorities were modified for specific lysimeters so that samples would be analyzed for analytes with less data.

Four years of aquifer and lysimeter baseline monitoring data are described in INL/RPT-23-74930, "Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory." INL/RPT-23-74930 recommended proposed changes to PLN-5501 based on data collected during the four years of baseline monitoring. Other changes are based on sample collection experience and lysimeter performance (ability to produce water) during that same period.

Description and Purpose of Planned Revisions to the Monitoring Plan

1. Proposed Change: Increase length of time for baseline data collection phase from 3 to 4 years.

Original Plan

- Collect baseline data for 3 years from commencement of operations. This is called the baseline data collection phase.

Revised Plan

- Extend baseline data collection phase to 4 years from commencement of operations. A preliminary evaluation of lysimeter data collected after 3 years of operations was performed prior to collection of samples in the spring of FY 2022. This evaluation determined that insufficient data had been collected to determine baseline concentrations for some lysimeters and analytes (see INL 2023a, Appendix B, Table B-6). As a result, the baseline data collection phase was extended another year, and analyte priorities were modified for specific lysimeters so that samples would be analyzed for analytes with less data. An analysis of four years of data in the baseline data report (INL 2023b), concluded that sufficient data had been collected over the first 4 years of operations to establish baseline conditions for future compliance monitoring of aquifer wells and performance monitoring of vadose-zone lysimeters. Therefore, the project moved from the baseline data-collection phase to the post-baseline monitoring phase after 4 years from the commencement of operations. This change will be documented in the revised monitoring plan.

2. Proposed Change: Revise gross-alpha action level for lysimeter samples during post-baseline monitoring phase from 10 to 20 pCi/L, and add tritium to analyte list.

Original Plan

- Gross alpha action level set to 10 pCi/L.
- Lysimeter samples during the post-baseline monitoring phase will be analyzed for indicator analytes gross alpha and gross beta.

Revised Plan

- The gross alpha action level will increase from 10 to 20 pCi/L per recommendation in the baseline data report (INL 2023b). Action levels in the original monitoring plan were established prior to monitoring. The initial gross-alpha action level of 10 pCi/L was not based on regional data, modeling, or protectiveness, but was established as a conservative value that is less than the gross-alpha drinking water standard. Based on 4 years of baseline lysimeter data, INL (2023b) recommended the gross-alpha action level for performance monitoring of lysimeters be increased from 10 to 20 pCi/L. An action level of 20 pCi/L is slightly greater than the 99% upper confidence limit (UCL) from 4 years of data, is protective of the aquifer, and would reduce unnecessary sampling.
- Tritium will be added to indicator analytes gross alpha and gross beta for the post-baseline monitoring phase sampling. Tritium, while not a dose concern, requires only 50 mL for analysis, and is a good tracer that can provide valuable information on water flow in and around the RHLLW Disposal Facility. This was demonstrated during the baseline data collection phase (Sondrup 2022).

3. Proposed Change: Revise lysimeters to be sampled and response actions for the post-baseline monitoring phase

Original Plan

- During the post-baseline monitoring phase, the original monitoring plan called for samples to be collected annually from each lysimeter near vault arrays where waste has been disposed of and only from lysimeters closest to vaults containing waste for vault arrays that have more than one sampling location. This includes shallow alluvium, deep alluvium, and shallow-interbed-well (SIW) lysimeters. Samples would be analyzed for indicator analytes gross alpha and gross beta. According to the original plan:
  - There are only 2 vault arrays with waste in 2024 (HFEF, 55-ton) and only 2 lysimeter locations would be sampled (See Figure 1, OLD, **BLUE CIRCLES**).
  - Other lysimeters would be sampled as waste is placed in nearby vaults (See Figure 1, OLD, **ORANGE CIRCLES**).
  - The PA vault lysimeters will not be sampled.

- Sampling would switch to semiannual if gross alpha or gross beta results were shown through trend analysis to exceed an action level, and semiannual samples would be speciated. Direction on performing the trend analysis and speciation was not specific.

Revised Plan

- The number of lysimeters to be sampled during the post-baseline monitoring phase will be reduced. Sampling during the baseline data collection phase indicated some lysimeters are better producers of water than others and some produced very little water at all—even after several attempts to obtain water. Collecting a sample consists of setting a vacuum on a lysimeter and extracting a sample 1 to 3 weeks later. After 1 to 3 weeks, any water in the lysimeters is pumped to the surface and collected. Each attempt to collect water is called a sample event. After extraction, the next event is started by resetting vacuum. It may require several events to collect enough water for analysis, and it may not be practical to attempt to secure the desired volume. Based on experience with water collection rates and considerations for good spatial coverage, lysimeters to be sampled during the post-baseline monitoring phase and response actions are as follows:
- Sample 1 shallow alluvium lysimeter from each vault array throughout the post-baseline monitoring phase (See Figure 1, NEW, **GREEN CIRCLES**). Selection of lysimeters to be sampled is discussed below.
  - 2 vault arrays (HFEF and 55-Ton) have one lysimeter each and both will be sampled (HFEF-South, and 55-Ton-South). This is not a change from the original plan.
  - The 3 other vault arrays (NuPac, LCC, and MFTC) have 2 lysimeter locations each. The shallow alluvium lysimeters to be sampled are NuPac-West, LCC-East and MFTC West. The basis for selecting these lysimeters is based on water production and how vault arrays are likely to be filled.
    - NuPac Array: Sample NuPac-West. NuPac-West and NuPac-East are good producers of water, but NuPac-West is a better producer and is more likely to provide 300+ mL from a single sampling event, enough to analyze for gross alpha, gross beta and tritium. In addition, the vault array will likely fill from west to east meaning NuPac-West would be closer to the earlier disposals.
    - LCC Array: Sample LCC-East. LCC-East is a much better producer of water than LCC-West and is likely to provide enough water from a single sampling event to analyze for gross alpha, gross beta and tritium. LCC-West would likely require 3 to 4 sampling events to provide 300+ mL of water. Although the LCC vault array is likely to fill from west to east, the HFEF-South lysimeter is closer to the west end of the array than LCC-West. Thus, LCC-East is more centrally located and both HFEF-South and LCC-East provide better coverage of the LCC Array.
    - MFTC Array: Sample MFTC-West. MFTC-West and MFTC-East are both good producers of water and both are likely to provide 300+ mL of water from a single sampling event. However, MFTC-West is a better producer of water and the vault array is likely to fill from W to E meaning MFTC-West would be closer to the earlier disposals.
- Sample 1 shallow interbed well (SIW) lysimeter, MFTC-East-SIW (See Figure 1, NEW, **GREEN CIRCLES**). Of the 3 SIW lysimeters, MFTC-East-SIW is the only good water producer and capable of producing 300+ mL in a single sampling event. The other 2 SIW lysimeters (NuPac-SIW and MFTC-West-SIW) would require a minimum of 3 sampling events and more likely would be 5 or more.
- Lysimeters that will not be sampled are shallow lysimeters NuPac East, LCC West, and MFTC East; all deep alluvium lysimeters, and SIW lysimeters NuPac SIW and MFTC West SIW. These will not be sampled unless an action level is exceeded in another lysimeter and sampling is deemed necessary by the PARC (See Figure 1, NEW, **GOLD CIRCLES**).
- Samples will be collected annually in the spring. Sampling will switch to semiannual (spring and fall) if gross alpha, gross beta or tritium exceeds an action level. Only the lysimeter that exceeded the action level would be sampled. Samples will be speciated if an action level is exceeded for two consecutive samples

(spring and fall, or fall and spring). Semiannual sampling will continue until two consecutive samples are less than the action level.

- The PA vault lysimeters will not be sampled during the post-baseline monitoring phase. This is not a change from the original plan.

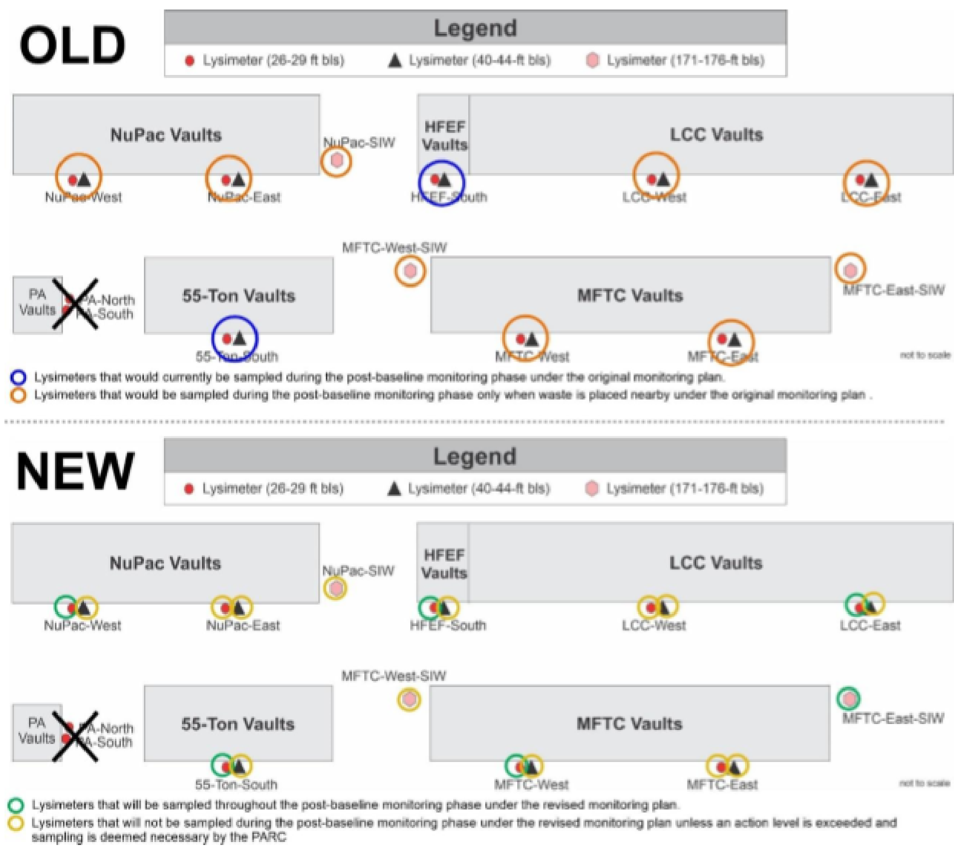


Figure 1. Comparison of lysimeters to be sampled during the post-baseline monitoring phase under the current (OLD) and proposed revised (NEW) monitoring plan. Lysimeters near PA vaults will not be sampled.

4. Proposed Change: Revise schedule/conditions for post-baseline monitoring phase annual lysimeter sampling

<u>Original Plan</u>

- Lysimeter samples during the post-baseline monitoring phase would be collected when water content reflectometer (WCR) data indicate sufficient water is present. The moisture content threshold for sampling would be established during the baseline data collection phase.

<u>Revised Plan</u>

- During the post-baseline monitoring phase, samples will continue to be collected using experience gained from sampling during the baseline data collection phase. Sample collection will begin in the spring after the majority of snow on and around the facility has melted and air temperatures are high enough to avoid freezing sample lines. Experience has shown it is not necessary to use WCR data to determine when a sample can or should be collected. In addition, the WCR data is not reliable for each instrument. The history of sample collection data suggests location is a better indicator of water availability than time of year as long as it occurs after the majority of snow has melted. Data suggests water can be collected in the spring and fall, but collection rates were slightly better on average in the spring. Sampling will commence in March or April after the majority of snow has melted. Experience has also shown that some lysimeters require several sampling attempts over one to three months to collect sufficient sample volume. Because moisture content can vary dramatically over this length of time in the spring and fall (depending on timing of spring snow melt and the occurrence of rainstorms), using moisture content data to plan sampling is less important.

5. Proposed Change: Revise compliance (aquifer) sampling response actions for exceedance of lysimeter action level

Original Plan

- Annual compliance sampling of the aquifer would switch to semiannual if a performance monitoring (lysimeter) action level were exceeded. It was unclear under what conditions semiannual compliance sampling would switch back to annual.

Revised Plan

- Annual compliance sampling of the aquifer will switch to semiannually only if a performance monitoring (lysimeter) action level were exceeded, AND semiannual sampling is determined necessary by the PARC. Given the thickness of the vadose zone at the RHLLW Disposal Facility (480 ft) and an average contaminant travel time to the aquifer of tens to hundreds of thousands of years (DOE 2018), annual sampling is sufficient to protect the aquifer. If additional information becomes available that suggests more frequent sampling is appropriate, the PARC can make that change.

Linkage of Changes to PA/CA Performance Objectives and DAS Conditions/Limitations

A review of the proposed changes to the monitoring plan concluded that they are not linked to PA/CA performance objectives or Operating Disposal Authorization Statement (ODAS) conditions/limitations, and do not have the potential to affect the assumptions and/or conclusions of the facility PA or CA. PA and CA assumptions and conclusions are not based on monitoring data collected after the start of operations. Monitoring data or lack of monitoring data does not have the potential to cause a performance objective/measure to be exceeded. Monitoring data is only used to demonstrate compliance (aquifer data) and build confidence that the facility is performing as demonstrated in the facility PA and CA (lysimeter data). The performance monitoring data that will be collected after implementation of these changes is considered to be sufficient to meet the objective of building confidence in the PA model. Based on this, the proposed changes do not require further screening or evaluation and it is recommended they be approved and adopted into the monitoring plan.

References

DOE. 2017. "Disposal Authorization Statement and Tank Closure Documentation." DOE-STD-5002-2017, U.S. Department of Energy.

DOE. 2018. "Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." DOE/ID-11421, Revision 2, U.S. Department of Energy Idaho Operations Office.

INL. 2023a. "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2022." INL/RPT-23-70876, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2023b. "Assessment of Baseline Data for the Remote-Handled Low-Level Waste Disposal Facility at the Idaho National Laboratory." INL/RPT-23-74930, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2024. "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2023." INL/RPT-24-76103, Idaho National Laboratory, Idaho Falls, Idaho.

PLN-5501. 2020. "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." Revision 2, Idaho National Laboratory, Idaho Falls, Idaho.

Sondrup, A.J. 2022. "Evaluation of Elevated Tritium in Lysimeter Samples at the Remote-Handled Low-Level Waste Disposal Facility." Revision 1, Idaho National Laboratory, Idaho Falls, Idaho.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments:

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments:

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments:

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments:

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☒ Positive ☐

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☒ UDQE ☐ Special Analysis ☐

A. Jeff Sondrup	Jeff Sondrup Jeff Sondrup (Sep 26, 2024 08:18 MDT)	Sep 26, 2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault Timothy Arsenault (Sep 26, 2024 09:15 MDT)	Sep 26, 2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☐

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☐

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☐

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☐

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☐

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-097

Subject: Canister ECF-05-18-119 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-05-18-119 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-05-18-119 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)

PA Check 9 was flagged by RHINO because the cumulative inventories of 17 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Hf-178m, Ir-192m, La-137, Np-237, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Fifteen of the 17 radionuclides flagged by PA Check 9 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 15 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The two key radionuclides (Np-237, and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)

PA Check 10 was flagged by RHINO because the cumulative inventory of two key radionuclides (Np-237, and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check

This flag was checked by RHINO because the waste canister contains 11 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. RHINO also identified two non-system/non-exempt radionuclides in the waste canister. These radionuclides in these waste forms must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-05-18-119 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Print/Type Name	Signature	Date
A. Jeff Sondrup Print/Type Name Originator/FDS	[signature] Signature Originator/FDS	05/29/2024 Date
Tim Arsenault Print/Type Name Approver/NFM	Timothy Arsenault Signature Approver/NFM	5/29/2024 Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, and 12 by RHINO that occurred during the acceptance check of waste canister ECF-05-18-119. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

Canister Details ECF-05-18-119

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	5/21/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	5/21/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	5/21/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	5/21/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	5/21/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	5/21/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	5/21/2024
	Yes	Gross Alpha	6.3703E-006	7.5	pCi/L	Post Compliance	5/21/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	5/21/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	5/21/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	5/21/2024
	Yes	Uranium	1.6901E-005	15	ug/L	Post Compliance	5/21/2024
7	Yes	Intruder	2.2071E-001	20	mrem/yr	Compliance	5/21/2024
8	Yes	Air Pathway	1.4349E-004	0.4	mrem/yr	Compliance	5/21/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/21/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/21/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/21/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check.	-			Compliance	5/21/2024
13	Yes	Canister Action Levels Check	-			Compliance	5/21/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: NRF
Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	3.0606E-007	2.0884E-007	8.1736E-009
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	9.2910E-008	5.3195E-008	1.9001E-008
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8429E-007	6.9997E-008	2.2479E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1609E-007	3.5211E-008	8.9891E-011
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.4589E-006	4.0123E-006	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.9577E-006	7.6070E-007	2.0108E-007
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.9899E-007	1.5450E-007	4.5346E-008
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	5.9743E-007	3.3543E-009	5.5963E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.7306E-005	8.0353E-005	1.5752E-006
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	1.5498E-003	3.8088E-004	2.4021E-006
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5854E-011	3.0840E-012	1.4179E-013
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.3867E-008	1.9187E-008	3.8208E-009
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	2.0238E-007	1.0867E-007	3.7951E-008
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8895E-008	2.5084E-009	4.9710E-010
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.3960E-008	1.5922E-008	3.8303E-009
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	5.1646E-006	4.7761E-007	2.8603E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	1.6838E-006	5.3927E-009	1.0082E-011

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Cd-113	A	NRF	3	1.5830E-023	7.7000E+015	1.3897E-024
Eu-152	S	NRF	3	1.0194E-006	1.3500E+001	8.9489E-008
Eu-154	S	NRF	3	1.1976E-006	8.5900E+000	1.0513E-007
Gd-152	A	NRF	3	5.9678E-017	1.0800E+014	7.2601E-023
Gd-152	S	NRF	3	8.2701E-022	1.0800E+014	7.2601E-023
H-3	S	NRF	3	1.3331E-006	1.2300E+001	1.1703E-007
Pb-210	A	NRF	3	2.2582E-014	2.2200E+001	1.9824E-015
Ra-228	S	NRF	3	8.2820E-013	5.7400E+000	7.2706E-014
Sm-147	S	NRF	3	4.7894E-015	1.0600E+011	4.2045E-016
Th-228	S	NRF	3	1.0304E-008	1.9100E+000	9.0461E-010
Th-229	S	NRF	3	6.5831E-012	7.8900E+003	5.7791E-013
Th-230	S	NRF	3	7.1753E-013	7.5400E+004	6.2991E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	3.2026E-024	S	Yes
Nd-144	2.7370E-023	A	Yes
Sm-146	1.3566E-024	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-05-18-119.

PA Check 9

The RHINO acceptance check for waste canister ECF-05-18-119 identified 17 radionuclides with half-lives greater than 1 year whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1).

One of the radionuclides that was flagged by PA Check 9, Hf-178m, is not in canister ECF-05-18-119 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0), and because it was evaluated under a previous UDQE (UDQE-RHLLW-094), it does not need to be evaluated here. Another of the radionuclides flagged by PA Check 9, Ce-142, was eliminated during the Phase I screening in the PA because there is no National Council on Radiation Protection (NCRP) screening dose factor (NCRP 1996), and the half-life is very long such that it is considered observationally stable. Therefore, it requires no further evaluation.

Of the remaining 15 radionuclides flagged by PA Check 9, 13 (Ac-227, Ce-142, Cm-245, Cm-246, Ir-192m, La-137, Pt-193, Pu-238, Ra-226, Ra-228, Rb-87, Th-229, Th-232, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the groundwater pathway dose[1] calculation during preparation of the PA. The cumulative inventories of these 13 non-key groundwater pathway radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. The other two radionuclides (Np-237, and U-234), are key groundwater pathway radionuclides and are evaluated under PA Check 10 (see below).

Groundwater Pathway

Nine of the 13 non-key groundwater pathway radionuclides (Cm-245, Cm-246, La-137, Pt-193, Ra-226, Ra-228, Rb-87, Th-229 and Th-232) were screened during the Phase II PA groundwater pathway screening, and the other four (Ac-227, Ir-192m, Pu-238, and U-236) were screened during Phase III PA groundwater pathway screening. Table 1 shows that the projected cumulative inventories of the 13 non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the projected cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-05-18-119) was added to the total PA base case inventory to obtain the projected cumulative inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{II_i}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x\ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

[1] In the PA, the groundwater pathway dose is the same as the all-pathways dose.

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10[th] the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-05-18-119 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 7) and would still be screened out. Thus, the inventories of the non-key radionuclides in waste canister ECF-05-18-119 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Dose Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase II Screening Inventory
Cm-245	2.25E-10	2.84E-07	5.28E-07	8.12E-07	6.29E+04	6.36E-06	12.8%
Cm-246	8.99E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
La-137	4.53E-08	4.99E-07	2.38E-06	2.88E-06	9.62E+02	4.16E-04	0.69%
Pt-193	1.58E-06	9.73E-05	6.64E-04	7.61E-04	2.92E+02	1.37E-03	55.6%
Ra-226	1.42E-13	5.59E-11	3.14E-11	8.73E-11	2.96E+05	1.35E-06	0.0065%
Ra-228	3.82E-09	3.39E-08	2.28E-07	2.62E-07	1.11E+05	3.60E-06	7.27%
Rb-87	3.80E-08	2.02E-07	1.28E-06	1.48E-06	4.44E+03	9.01E-05	1.65%
Th-229	4.97E-10	2.89E-08	5.35E-08	8.24E-08	1.18E+05	3.38E-06	2.44%
Th-232	3.83E-09	3.40E-08	2.48E-07	2.82E-07	3.66E+05	1.09E-06	25.8%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase III Screening Inventory
Ac-227	8.17E-09	3.06E-07	5.76E-06	6.07E-06	1.00E-40	2.30E+34	2.63E-38%
Ir-192m	2.01E-07	1.96E-06	1.07E-05	1.27E-05	1.00E-40	4.28E+34	2.96E-38%
Pu-238	2.40E-06	1.55E-03	3.68E-01	3.70E-01	2.57E-02	5.73E+00	6.45%
U-236	1.01E-11	1.68E-06	5.88E-05	6.05E-05	1.04E-02	2.26E-03	2.67%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018). Original reference is NCRP 1996.
d. $Imax_{IIi}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{IIIi}$ from Equation 2 above.

PA Check 10

Waste canister ECF-05-18-119 contains two key radionuclides (Np-237, and U-234) whose cumulative inventories (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). These radionuclides are considered key radionuclides for the groundwater pathway and their contributions are included in the RHINO all-pathways dose calculation.

It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-05-18-119. The projected all-pathways dose after disposal of canister ECF-05-18-119 would increase by 0.000000072% for the compliance period and 0.13% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of canister ECF-05-18-119 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of waste canister ECF-05-18-119 would increase by 0.75%. This is a small increase and the total intruder dose of 0.186 mrem/yr is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario).

The increases in other performance measures are also small. The increase in the air pathway dose is 8.05%, and the projected dose of 1.43E-04 mrem/yr is much less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of key radionuclides Np-237, and U-234 would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-05-18-119 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of proposed canister ECF-05-18-119.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister (mrem/yr)	Placed Canisters + Proposed Canister (mrem/yr)	% Increase in All-Pathways Dose After Placement of Proposed Canister
All Pathways Dose	Compliance	mrem/yr	1	25	9.68E-14	1.35E-04	0.000000072%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	9.99E-05	7.88E-02	0.13%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	6.87E-14	9.62E-05	0.000000071%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	1.73E-04	5.60E-02	0.31%
Ra-226/228	Compliance	pCi/L	0.2	5	1.36E-41	2.19E-32	0.000000062%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.32E-10	2.04E-06	0.006%
Gross Alpha	Compliance	pCi/L	0.6	15	4.15E-37	4.55E-30	0.0000091%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	9.75E-10	6.37E-06	0.015%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	3.76E-14	5.26E-05	0.000000071%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	2.86E-05	3.06E-02	0.094%
Uranium	Compliance	ug/L	1.2	30	3.71E-34	8.88E-28	0.000042%
Uranium	Post-Compliance	ug/L	15	30	3.13E-08	1.69E-05	0.19%
Intruder	Compliance	mrem/yr	20	100	9.18E-03	2.21E-01	4.34%
Air Pathway	Compliance	mrem/yr	0.4	10	1.07E-05	1.43E-04	8.05%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-05-18-119 contains 12 unanalyzed radionuclide/waste form combinations with half-lives greater than one year.[2] These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these radionuclides when compared to the total canister inventory (1139 Ci) are much less than 1% (see Table 5, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[3]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Table 5 shows that 9 of the 12 radionuclide/waste form combinations were reported in other waste streams (Column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory for these radionuclides (Column 2 ÷ Column 5). This is evidence that the unanalyzed radionuclides in canister ECF-05-18-119 will not impact the conclusions of the PA.

Table 5. Unanalyzed radionuclides in waste canister ECF-05-18-119 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Proposed Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Cd-113	1.58E-23	AM	1.39E-24%	N/A	N/A	N/A
Eu-152	1.02E-06	SC	8.95E-08%	4.14E+00	0.00002%	III
Eu-154	1.20E-06	SC	1.05E-07%	1.56E+01	0.00001%	III
Gd-152	5.97E-17	AM	5.24E-18%	N/A	N/A	N/A
Gd-152	8.27E-22	SC	7.26E-23%	N/A	N/A	N/A
H-3	1.33E-06	SC	1.17E-07%	1.99E+03	0.0000001%	Retained
Pb-210	2.26E-14	AM	1.98E-15%	2.89E-12	0.78%	II
Ra-228	8.28E-13	SC	7.27E-14%	2.28E-07	0.0004%	II
Sm-147	4.79E-15	SC	4.20E-16%	1.38E-10	0.003%	II
Th-228	1.03E-08	SC	9.05E-10%	2.02E-04	0.01%	III
Th-229	6.58E-12	SC	5.78E-13%	5.35E-08	0.01%	II
Th-230	7.18E-13	SC	6.30E-14%	4.93E-08	0.001%	II

a. AM = Activated Metal, SC = surface contamination

b. Based on a total canister inventory of 1139 Ci (from RHINO).

N/A = Not Applicable. Not included in any base case PA waste streams.

Three of the 12 unanalyzed radionuclide/waste form combinations were not reported in any other PA waste streams and were evaluated further. All have half-lives greater than 1 year so they would not be screened by the

[2] There are 11 radionuclides, but Gd-152 is reported as both an activated metal and surface contamination so there are 12 combinations.

[3] Although the H-3 inventory is less than 1% of the total canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact is included in RHINO calculations and H-3 does not need to be evaluated here.

PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6). Since the Phase II screening is done by total inventory regardless of waste form, the Gd-152 AM and SC inventories were combined. The maximum PA Phase II screening inventory in Table 6 Column 6 is calculated using Equation 1. All of the values in Column 7 are very small indicating these radionuclides would have been screened from the PA. As these and other unanalyzed radionuclides appear in future waste canisters, the same calculation will continue to be performed.

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Total Facility Inventory of Previously Placed Canisters (Ci)	Sum of Proposed and Previously Placed Canisters (Ci)	NCRP Screening Dose Factor (mrem/Ci)[a]	Maximum Allowable Phase II Screening Inventory (Ci)	Sum of Proposed and Previously Placed Canisters Inventory as % of Max Allowable Phase II Screening Inventory
Cd-113	1.58E-23	1.43E-21	1.44E-21	2.07E+05	1.93E-06	0.00000000000007%
Gd-152	5.97E-17	2.59E-16	3.19E-16	5.92E+03	6.76E-05	0.0000000005%

a. NCRP (1996).

Non-system Radionuclides

Figure 1 shows waste canister ECF-05-18-119 contains two non-system radionuclides (Nd-144 and Sm-148). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 7 shows radionuclide Nd-144 is listed in the canister inventory as both an activated metal and surface contamination, and Sm-148 is listed as an activated metal waste form. The long half-lives (>1E+15 years) coupled with the very small inventories (< 1E-22 Ci) indicate the presence of these radionuclides will not have an impact on the PA.

Table 7. Non-system radionuclides in waste canister ECF-05-18-11 .

Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Half-Life (years)
Nd-144	3.20E-24	SC	2.3E+15
Nd-144	2.74E-23	AM	2.3E+15
Sm-148	1.36E-24	AM	7.0E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-05-18-119 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

NCRP, 1996, *Screening Models for Releases of Radionuclides to Atmospheric, Surface Water, and Ground - Worksheets*, NCRP Report No. 123 II (Vol. 2), National Council on Radiation Protection and Measurement.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-094, 2024, "Canister ECF-01-21-104 from NRF flagged by RHINO during PA checks," May 2024.

Print/Type Name	Signature	Date
Jonathan Jacobson Print/Type Name Originator/FDS	Jonathan Jacobson Signature Originator/FDS	05/30/2024 Date
A. R. Prather Print/Type Name System Engineer/SE	A. R. Prather Signature System Engineer/SE	5/30/24 Date
A. Jeff Sondrup Print/Type Name PA/CA SME	Jeff Sondrup Signature PA/CA SME	05/30/2024 Date
Paul A. Velasquez Print/Type Name Waste Management/WMP	Paul A. Velasquez Signature Waste Management/WMP	05/30/2024 Date
Tim Arsenault Print/Type Name Nuclear Facility Manger/NFM	Timothy Arsenault Signature Nuclear Facility Manger/NFM	5/30/2024 Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-098

Subject: ATR-5 Canister ATRRH24003/814600-12 flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ATRRH24003/814600-12 is an ATR-5 waste canister containing activated metals from the Advanced Test Reactor (ATR) Complex. Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ATRRH24003/814600-12 was flagged by RHINO for the following:

PA Check 12: Waste canister ATRRH24003/814600-12 was flagged by RHINO because it contains a radionuclide with a half-life greater than 1 year that was not analyzed in the PA for this particular generator, canister type and waste form. The radionuclide is Co-60 and the waste form is surface contamination.

Radionuclides in a particular waste form from a specific generator, and in a specific canister type that were not considered in the PA fit the definition of a change that must be evaluated before the canister can be accepted according to RH-ADM-5214.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

   Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

   Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Waste canister ATRRH24003/814600-12 was flagged by RHINO while performing PA checks. The flag indicates there is a change from what was considered in the PA that must be evaluated.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson	6/24/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	6/24/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

Explanation:

Waste canister ATRRH24003/814600-12 was flagged by RHINO while performing PA checks as part of the acceptance process for disposal. Figure 1 shows the canister details page from RHINO and the results of the PA checks.

Canister Details 814600-12

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: HFEF-5 Can

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	6/19/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	6/19/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	6/19/2024
	Yes	Beta-Gamma DE	5.5966E-002	2.4	mrem/yr	Post Compliance	6/19/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	6/19/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	6/19/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	6/19/2024
	Yes	Gross Alpha	6.3706E-006	7.5	pCi/L	Post Compliance	6/19/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	6/19/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	6/19/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	6/19/2024
	Yes	Uranium	1.6901E-005	15	ug/L	Post Compliance	6/19/2024
7	Yes	Intruder	2.2470E-001	20	mrem/yr	Compliance	6/19/2024
8	Yes	Air Pathway	1.5096E-004	0.4	mrem/yr	Compliance	6/19/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	6/19/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	6/19/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	6/19/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check.	-			Compliance	6/19/2024
13	Yes	Canister Action Levels Check	-			Compliance	6/19/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: ATR | Array: All

No Results Found

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Co-60	S	ATR	2	1.2900E-006	5.2600E+000	4.9507E-007

Figure 1. PA Check output screen from RHINO for ATR-5 waste canister ATRRH24003/814600-12.

Although Figure 1 shows PA checks 9 and 10 as failed, this is the result of radionuclides from other generators, in other canister types, and waste forms. They were evaluated in previous UDQEs and are not a concern for this evaluation.

PA Check 12: PA check 12 was flagged by RHINO because the canister contains a radionuclide (Co-60) with a half-life greater than 1 year that was not analyzed in the PA for this particular generator (ATR), canister type (ATR-5) and waste form (surface contamination).

During preparation of the PA, the projected radionuclide inventory for ATR-5 waste canisters only included radionuclides in activated metals. No radionuclides were listed as surface contamination. The RHLLW Disposal Facility was notified by the ATR Canal Cleanout Project in 2021 that residual contamination from ATR canal water activity could be present on the surfaces of the activated metals loaded inside the waste baskets and on the inner and outer surfaces of the baskets. The surface contamination radionuclides and relative abundances were obtained from canal chemistry results from 2020 and 2021. The activities were estimated to be minor (uCi or less for individual canisters) and most of the radionuclides that could be present have half-lives less than one year which are not a concern from a PA standpoint. Based on this information, it was decided that surface contamination would be reported, but canister acceptance would be evaluated on a canister-by-canister basis until a more efficient process is developed.

Because Co-60 is a key radionuclide (for the intruder pathway) the minimum reporting limit is 1E-12 Ci. Although the 1.29E-06 Ci of Co-60 as surface contamination in canister ATRRH24003/814600-12 is greater than the reporting limit, it is insignificant compared to the amount of Co-60 reported as surface contamination for all generators combined (734 Ci, see PA [DOE-ID 2018], Table 2-14), and the amount of Co-60 reported for all waste forms from all generators (309,000 Ci, see PA [DOE-ID 2018], Table 2-14). Therefore, the Co-60 as surface contamination in canister ATRRH24003/814600-12 is within the bounds of the PA and the canister is acceptable for disposal.

> Note: Co-60 is not a key radionuclide for the groundwater pathway in the PA. The amount of Co-60 acceptable from a groundwater pathway perspective is greater than 1E+40 Ci based on the Phase III screening in the PA. However, Co-60 is a key radionuclide for the intruder pathway. Although Co-60 as surface contamination from ATR was not evaluated in the PA, all Co-60 activity regardless of waste form or generator is included in the intruder pathway dose calculated by RHINO. Nevertheless, the inventory of Co-60 as surface contamination in future ATR-5 canisters could be at least 1E+06 times the amount in canister ATRRH24003/814600-12 and still be acceptable based on intruder dose performance objectives.

Summary:

Co-60 as surface contamination in canister ATRRH24003/814600-12 is within the bounds of the PA and the canister is acceptable for disposal.

Recommendations:

It is recommended the RHLLW disposal project update Table B-1 of PLN-5446, Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility to include the nine radionuclides (Co-58, Co-60, Cr-51, Hf-175, Hf-181, Mo-99, Na-24, Re-188, and Sb-124) reported as surface contamination on ATR activated metal components and the waste basket. The appropriate table in RHINO should also be updated to include these nine radionuclides so that RHINO will not flag them as unanalyzed. Co-60 is the only one of the nine with a half-life greater than 1 year, and it will continue to be flagged by PA Check 12 (unanalyzed with half-life > 1 year) until the RHINO table is updated.

References:

DOE-ID 2018, "Performance Assessment for the Idaho National Laboratory Remote Handled Low Level Waste Disposal Facility," DOE/ID-11421, Idaho National Laboratory.

PLN-5546, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory.

Jonathan Jacobson	Jonathan Jacobson	06/24/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
James Angell for Allen Prather per telecon	James Angell	06/25/2024
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	06/24/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul A. Velasquez	06/24/2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	6/24/2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

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Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-099

Subject: Canister ECF-01-21-129 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-129 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-129 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 9 was flagged by RHINO because the cumulative inventories of 21 radionuclides (Ac-227, Ce-142, Cm-245, Cm-246, Cs-137, Hf-178m, Ir-192m, Kr-85, La-137, Np-237, Pt-193, Pu-238, Pu-240, Ra-226, Ra-228, Rb-87, Sr-90, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Sixteen of the 21 radionuclides flagged by PA Check 9 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 16 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA Check 10 was flagged by RHINO because the cumulative inventory of five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because the waste canister contains 16 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. RHINO also identified two non-system/non-exempt radionuclides in the waste canister. These radionuclides in these waste forms must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-129 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

A. Jeff Sondrup	Jeff Sondrup	06/27/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	6/27/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-129. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

PA Check 9

The RHINO acceptance check for waste canister ECF-01-21-129 identified 21 radionuclides with half-lives greater than 1 year whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). However, six radionuclides (Ce-142, Ir-192m, La-137, Ra-228, Rb-87, and Th-232) that were flagged by PA Checks 9 and 10 are not in canister ECF-01-21-129 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0). These radionuclides were evaluated under a previous UDQE, and do not need to be evaluated here.

Canister Details ECF-01-21-129

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	6/18/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	6/18/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	6/18/2024
	Yes	Beta-Gamma DE	5.5965E-002	2.4	mrem/yr	Post Compliance	6/18/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	6/18/2024
	Yes	Ra-226/228	2.0428E-006	2.5	pCi/L	Post Compliance	6/18/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	6/18/2024
	Yes	Gross Alpha	8.3706E-006	7.5	pCi/L	Post Compliance	6/18/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	6/18/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	6/18/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	6/18/2024
	Yes	Uranium	1.8901E-005	15	ug/L	Post Compliance	6/18/2024
7	Yes	Intruder	2.4451E-001	20	mrem/yr	Compliance	6/18/2024
8	Yes	Air Pathway	1.5427E-004	0.4	mrem/yr	Compliance	6/18/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	6/18/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	6/18/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	6/18/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check.	-			Compliance	6/18/2024
13	Yes	Canister Action Levels Check	-			Compliance	6/18/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**.

Generator Facility: NRF | Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	3.0606E-007	2.0884E-007	8.6522E-013
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	9.2910E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8452E-007	6.9997E-008	6.7311E-011
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1618E-007	3.6211E-008	2.6899E-011
Cs-137 [Details]	3.0100E+001	S	55-Ton Cask	NRF	3	West	8.0715E-002	6.9179E-002	7.9738E-005
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	5.9121E-008	4.0123E-008	2.6972E-007
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.9677E-006	7.6070E-007	
Kr-85 [Details]	1.0700E+001	S	55-Ton Cask	NRF	3	West	3.8282E-003	3.4951E-003	8.8372E-007
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.9899E-007	1.5450E-007	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	7.7230E-007	3.3543E-009	1.4217E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.7314E-005	8.0353E-005	7.6771E-009
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	3.8461E-003	3.8088E-004	1.1126E-006
Pu-240 [Details]	6.5600E+003	S	55-Ton Cask	NRF	3	West	6.2786E-005	6.2158E-005	6.8323E-008
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5981E-011	3.0840E-012	1.0458E-013
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.3867E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	2.0238E-007	1.0867E-007	
Sr-90 [Details]	2.8900E+001	S	55-Ton Cask	NRF	3	West	8.2221E-002	6.9832E-002	6.3510E-005
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8895E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.3960E-008	1.5922E-008	1.6258E-018
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	6.2676E-006	4.7761E-007	8.3082E-010
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	2.1770E-006	5.3927E-009	2.9663E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	3.0369E-008	7.1600E+005	9.8862E-010
Cd-113	A	NRF	3	4.9060E-022	7.7000E+015	1.5974E-023
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	3.3972E-008
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	4.0447E-008
H-3	S	NRF	3	1.3676E-006	1.2300E+001	4.4529E-008
Lu-173	A	NRF	3	4.7121E-012	1.3700E+000	1.5342E-013
Lu-174	A	NRF	3	1.6781E-008	3.3000E+000	5.4640E-010
Mn-53	A	NRF	3	3.2890E-008	3.7400E+006	1.0709E-009
Ra-228	S	NRF	3	2.3222E-013	5.7400E+000	7.5609E-015
Re-186m	A	NRF	3	9.1863E-009	2.0000E+005	2.9907E-010
Sm-147	S	NRF	3	2.2278E-016	1.0600E+011	7.2536E-018
Ta-179	A	NRF	3	6.8976E-011	1.8200E+000	2.2459E-012
Th-228	S	NRF	3	3.0816E-009	1.9100E+000	1.0034E-010
Th-229	S	NRF	3	1.4031E-012	7.8900E+003	4.5686E-014
Th-230	S	NRF	3	1.5208E-013	7.5400E+004	4.9511E-015
Tl-204	A	NRF	3	6.2030E-009	3.7700E+000	2.0197E-010

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	1.2765E-005	A	Yes
Nd-144	2.8509E-027	S	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-129.

Of the remaining 15 radionuclides, 12 (Ac-227, Cm-245, Cm-246, Cs-137, Hf-178m, Kr-85, Pt-193, Pu-238, Ra-226, Sr-90, Th-232, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the groundwater pathway dose[1] calculation during preparation of the PA. Kr-85 was screened during Phase I because even though it has a half-life greater than 1 year, it is a gas and will not contribute to the groundwater pathway dose or the intruder dose. The Kr-85 impact on the air pathway is evaluated below. The cumulative inventories of the other 11 non-key groundwater pathway radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. The other three radionuclides (Np-237, Pu-240, and U-234) are key groundwater pathway radionuclides and are evaluated under PA Check 10 (see below). Cs-137 and Sr-90 are key intruder pathway radionuclides and are also evaluated under PA Check 10 (see below).

Groundwater Pathway

Of the 11 radionuclides screened from the groundwater pathway calculation during the PA Phase II and III screening, six (Cm-245, Cm-246, Hf-178m, Pt-193, Ra-226, and Th-232) were screened during Phase II, and the other five (Ac-227, Cs-137, Pu-238, Sr-90 and U-234) were screened during Phase III. Table 1 shows that except for Hf-178m, the projected cumulative inventories of the non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the projected cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-129) was added to the total PA base case inventory to obtain the projected cumulative inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-129 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the non-key

[1] In the PA, the groundwater pathway dose is the same as the all-pathways dose.

radionuclides in ECF-01-21-129 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory (see Table 1, Column 8), the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated. According to the evaluation in UDQE-RHLLW-087, it would require 4E+39 Ci of Hf-178m to fail the PA Phase III screening criteria, and more than 30,000 Ci of Hf-178m to cause a significant intruder dose. Based on the cumulative Hf-178m inventory from Table 1 (5.33E-06 Ci), Hf-178m will have no impact on the conclusions of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Dose Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase II Screening Inventory
Cm-245	6.73E-11	2.85E-07	5.28E-07	8.13E-07	6.29E+04	6.36E-06	12.8%
Cm-246	2.69E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Hf-178m	2.70E-07	5.91E-06	4.01E-08	5.95E-06	9.25E+04	4.32E-06	**138%**
Pt-193	7.68E-09	9.73E-05	6.64E-04	7.61E-04	2.92E+02	1.37E-03	55.6%
Ra-226	1.05E-13	5.60E-11	3.14E-11	8.74E-11	2.96E+05	1.35E-06	0.006%
Th-232	1.63E-18	3.40E-08	2.48E-07	2.82E-07	3.66E+05	1.09E-06	25.8%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase III Screening Inventory
Ac-227	8.65E-13	3.06E-07	5.76E-06	6.07E-06	1.00E-40	2.30E+34	2.63E-39%
Cs-137	7.97E-05	8.07E-02	9.45E+02	9.45E+02	1.00E-40	3.78E+42	2.50E-38%
Pu-238	1.11E-06	3.85E-03	3.68E-01	3.72E-01	2.57E-02	5.73E+00	6.49%
Sr-90	6.35E-05	8.22E-02	6.73E+02	6.73E+02	1.00E-40	2.69E+42	2.50E-38%
U-236	2.97E-12	2.18E-06	5.88E-05	6.10E-05	1.04E-02	2.26E-03	2.70%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018). Original reference is NCRP 1996.
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Air Pathway

As previously stated, Kr-85 was screened during Phase II of the air pathway screening. Here, the Kr-85 inventory was evaluated to determine if the new cumulative inventory would still be screened from the air pathway. Air pathway screening is based on the total PA base case inventory of all generators. The total amount of Kr-85 evaluated in the PA is 50.4 Ci. Canister ECF-01-21-129 contains 8.84E-07 Ci of Kr-85 and the cumulative amount thus far in all vault arrays is 3.83E-03 Ci (see Figure 1), or 0.008% of the PA base case inventory (50.4 Ci). The small additional amount in canister ECF-01-21-129 is insignificant compared to the PA base case inventory and would not result in Kr-85 being retained as a key air pathway radionuclide. Therefore, the Kr-85 inventory in canister ECF-01-21-129 is within the bounds of the PA.

PA Check 10

Waste canister ECF-01-21-129 contains three key groundwater pathway radionuclides (Np-237, Pu-240, and U-234) and two key intruder pathway radionuclides (Cs-137, and Sr-90). The cumulative inventory of these radionuclides (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1).

The contributions of key groundwater pathway radionuclides are included in the RHINO all-pathways dose calculation. Key intruder pathway radionuclides are included in the RHINO intruder dose calculation. It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-129. The projected all-pathways dose after disposal of canister ECF-01-21-129 would increase by 0.00000003% for the compliance period and 0.06% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of canister ECF-01-21-129 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of waste canister ECF-01-21-129 would increase by 10.1%. and the total intruder dose is 0.245 mrem/yr. This is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario).

The increases in other performance measures are also small. The increase in the air pathway dose is 2.24%, and the projected dose of 1.54E-04 mrem/yr is much less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of some key radionuclides would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-01-21-129 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of proposed canister ECF-01-21-129.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister (mrem/yr)	Placed Canisters + Proposed Canister (mrem/yr)	% Increase in All-Pathways Dose After Placement of Proposed Canister
All Pathways Dose	Compliance	mrem/yr	1	25	3.85E-14	1.35E-04	0.00000003%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	4.48E-05	7.88E-02	0.06%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	2.73E-14	9.62E-05	0.00000003%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	4.33E-04	5.60E-02	0.78%
Ra-226/228	Compliance	pCi/L	0.2	5	4.89E-42	2.19E-32	0.00000002%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	5.87E-11	2.04E-06	0.003%
Gross Alpha	Compliance	pCi/L	0.6	15	1.76E-37	4.55E-30	0.000004%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	2.87E-10	6.37E-06	0.005%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	1.50E-14	5.26E-05	0.00000003%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.28E-05	3.06E-02	0.042%
Uranium	Compliance	ug/L	1.2	30	1.65E-34	8.88E-28	0.00002%
Uranium	Post-Compliance	ug/L	15	30	1.27E-08	1.69E-05	0.08%
Intruder	Compliance	mrem/yr	20	100	2.24E-02	2.45E-01	10.1%
Air Pathway	Compliance	mrem/yr	0.4	10	3.37E-06	1.54E-04	2.24%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-129 contains 16 unanalyzed radionuclide/waste form combinations with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these radionuclides when compared to the total canister inventory (3071 Ci) are much less than 1% (see Table 5, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[2]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Table 5 shows that 9 of the 16 radionuclide/waste form combinations were reported in other waste streams (Column 5). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory for these radionuclides (Column 2 ÷ Column 5) with the exception of Tl-204. This is evidence that these unanalyzed radionuclides in canister ECF-01-21-129 will not impact the conclusions of the PA. Tl-204 was evaluated further with the other radionuclides not reported in other waste streams.

Table 5. Unanalyzed radionuclides in waste canister ECF-01-21-129 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Proposed Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Al-26	3.04E-08	AM	9.89E-10	N/A	N/A	N/A
Cd-113	4.91E-22	AM	1.60E-23	N/A	N/A	N/A
Eu-152	1.04E-06	SC	3.40E-08	4.14E+00	0.00003%	III
Eu-154	1.24E-06	SC	4.04E-08	1.56E+01	0.000008%	III
H-3	1.37E-06	SC	4.45E-08	1.99E+03	0.00000007%	Retained
Lu-173	4.71E-12	AM	1.53E-13	N/A	N/A	N/A
Lu-174	1.68E-08	AM	5.46E-10	N/A	N/A	N/A
Mn-53	3.29E-08	AM	1.07E-09	N/A	N/A	N/A
Ra-228	2.32E-13	SC	7.56E-15	2.28E-07	0.0001%	II
Re-186m	9.19E-09	AM	2.99E-10	N/A	N/A	N/A
Sm-147	2.23E-16	SC	7.25E-18	1.38E-10	0.0002%	II
Ta-179	6.90E-11	AM	2.25E-12	N/A	N/A	N/A
Th-228	3.08E-09	SC	1.00E-10	2.02E-04	0.002%	III
Th-229	1.40E-12	SC	4.57E-14	5.35E-08	0.003%	II
Th-230	1.52E-13	SC	4.95E-15	4.93E-08	0.0003%	II
Tl-204	6.20E-09	AM	2.02E-10	1.10E-22	5.64E+15%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 3071 Ci (from RHINO).
N/A = Not Applicable. Not included in any base case PA waste streams.

[2] Although the H-3 inventory is less than 1% of the total canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact is included in RHINO calculations (see PA Check 10). Therefore, H-3 does not need to be evaluated here.

Seven of the 16 unanalyzed radionuclide/waste form combinations were not reported in any other PA waste streams. These were evaluated further along with Tl-204. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6). The maximum PA Phase II screening inventory in Table 6 Column 6 is calculated using Equation 1. All of the values in Column 7 are very small indicating these radionuclides would have been screened from the PA. As these and other unanalyzed radionuclides appear in future waste canisters, the same calculation will continue to be performed.

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Total Facility Inventory of Previously Placed Canisters (Ci)	Sum of Proposed and Previously Placed Canisters (Ci)	NCRP Screening Dose Factor (mrem/Ci)[a]	Maximum Allowable Phase II Screening Inventory (Ci)	Sum of Proposed and Previously Placed Canisters Inventory as % of Max Allowable Phase II Screening Inventory
Al-26	3.04E-08	1.25E-07	1.55E-07	1.11E+05	3.60E-06	4.31%
Cd-113	4.91E-22	1.44E-21	1.93E-21	2.06E+05	1.94E-06	0.0000000000001%
Lu-173	4.71E-12	1.49E-05	1.49E-05	5.55E+02	7.21E-04	2.06%
Lu-174	1.68E-08	4.04E-06	4.06E-06	1.22E+03	3.28E-04	1.24%
Mn-53	3.29E-08	1.08E-07	1.41E-07	1.67E+02	2.40E-03	0.01%
Re-186m	9.19E-09	4.22E-08	5.14E-08	1.37E+04	2.92E-05	0.18%
Ta-179	6.90E-11	3.21E-05	3.21E-05	1.89E+02	2.12E-03	1.52%
Tl-204	6.20E-09	6.66E-26	6.20E-09	4.07E+02	9.83E-04	0.0006%

a. NCRP (1996).

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-129 contains two non-system radionuclides (Nb-91 and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 7 shows that Nd-144 has a very long half-life. The long half-life (>1E+15 years) coupled with the very small inventory (< 1E-26 Ci) indicate this radionuclide will not have an impact on the PA.

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The inventory of Nb-91 in canister ECF-01-21-129 is insignificant compared to 9E+16 Ci and will not impact the PA.

Table 7. Non-system radionuclides in waste canister ECF-01-21-129 .

Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Half-Life (years)
Nb-91	1.28E-05	AM	6.8E+02
Nd-144	2.85E-27	SC	2.3E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-129 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

NCRP, 1996, *Screening Models for Releases of Radionuclides to Atmospheric, Surface Water, and Ground - Worksheets*, NCRP Report No. 123 II (Vol. 2), National Council on Radiation Protection and Measurement.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

Print/Type Name	Signature	Date
Jonathan Jacobson	Jonathan Jacobson	06/27/2024
Originator/FDS	Originator/FDS	
A. R. Prather	A. R. Prather	7/1/24
System Engineer/SE	System Engineer/SE	
A. Jeff Sondrup	Jeff Sondrup	06/27/2024
PA/CA SME	PA/CA SME	
Paul A. Velasquez	Paul A. Velasquez	06/27/2024
Waste Management/WMP	Waste Management/WMP	
Tim Arsenault	Timothy Arsenault	7/09/2024
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-101

Subject: Canister ECF-01-21-122 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-122 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-122 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 9 was flagged by RHINO because the cumulative inventories of 24 radionuclides (Ac-227, Ar-39, Ce-142, Cm-245, Cm-246, Cs-137, Hf-178m, Hf-182, Ir-192m, Kr-85, La-137, Lu-176, Np-237, Pt-193, Pu-238, Pu-240, Ra-226, Ra-228, Rb-87, Sr-90, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Nineteen of the 24 radionuclides flagged by PA Check 9 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 19 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The five key radionuclides flagged by RHINO (Cs-137, Np-237, Pu-240, Sr-90 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA Check 10 was flagged by RHINO because the cumulative inventory of five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because the waste canister contains 17 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. RHINO also identified three non-system/non-exempt radionuclides in the waste canister. These radionuclides in these waste forms must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations,*

Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-122 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Kira Overin	*Kira Overin*	8/12/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	*Tim Arsenault*	8/12/2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

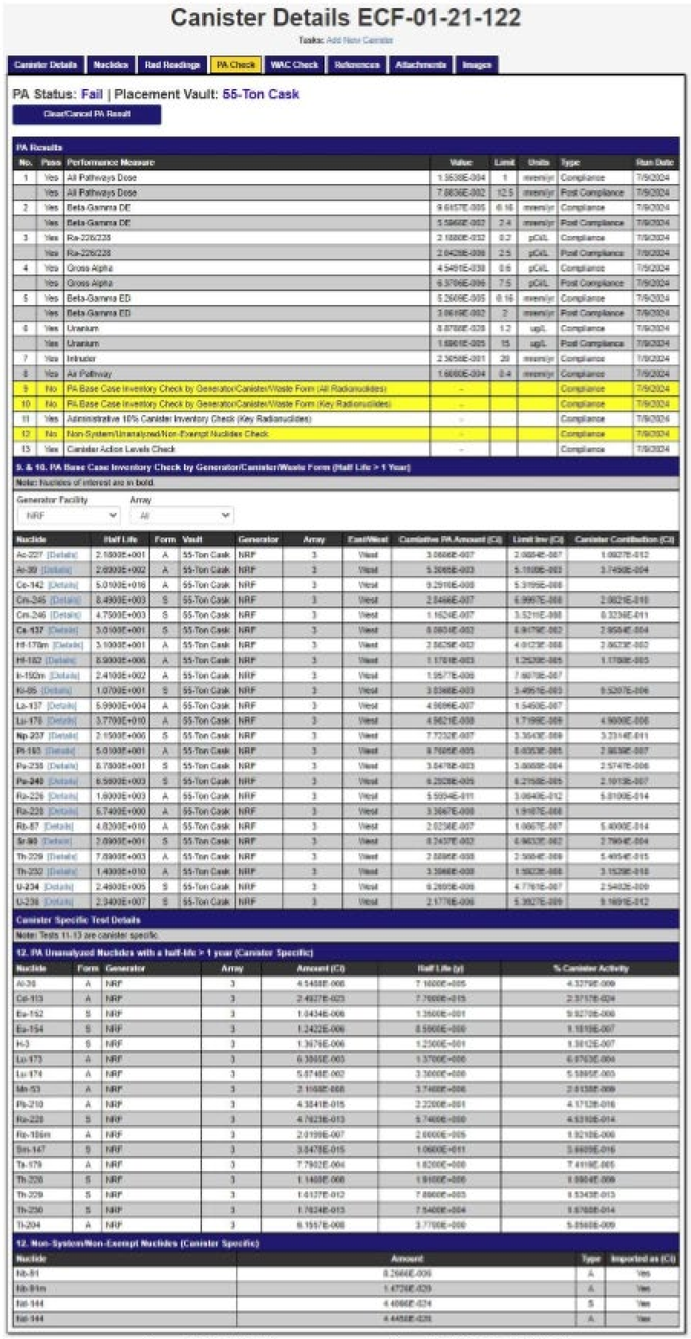
If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-122. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

PA Check 9

The RHINO acceptance check for waste canister ECF-01-21-122 identified 24 radionuclides with half-lives greater than 1 year whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). However, four radionuclides (Ce-142, Ir-192m, La-137, and Ra-228) that were flagged by PA Checks 9 and 10 are not in canister ECF-01-21-122 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0). These radionuclides were evaluated under a previous UDQE, and do not need to be evaluated here.



Canister Details ECF-01-21-122

Tasks: Add New Canister

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

Clear/Cancel PA Result

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3638E-004	1	mrem/yr	Compliance	7/9/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	7/9/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	7/9/2024
	Yes	Beta-Gamma DE	5.5860E-002	2.4	mrem/yr	Post Compliance	7/9/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	7/9/2024
	Yes	Ra-226/228	2.0429E-008	2.5	pCi/L	Post Compliance	7/9/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	7/9/2024
	Yes	Gross Alpha	6.3796E-006	7.5	pCi/L	Post Compliance	7/9/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	7/9/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	7/9/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	7/9/2024
	Yes	Uranium	1.6961E-005	15	ug/L	Post Compliance	7/9/2024
7	Yes	Intruder	2.3658E-001	20	mrem/yr	Compliance	7/9/2024
8	Yes	Air Pathway	1.6600E-004	0.4	mrem/yr	Compliance	7/9/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	7/9/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	7/9/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	7/9/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	7/9/2024
13	Yes	Canister Action Levels Check	-			Compliance	7/9/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold.

Generator Facility: NRF | Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumulative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	3.0666E-007	2.0804E-007	1.0027E-012
Ar-39 [Details]	2.6900E+002	A	55-Ton Cask	NRF	3	West	5.3065E-003	5.1100E-003	3.7450E-004
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	9.2510E-008	5.3195E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.0466E-007	6.9997E-008	2.0821E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1624E-007	3.5211E-008	8.3236E-011
Cs-137 [Details]	3.0100E+001	S	55-Ton Cask	NRF	3	West	8.0804E-002	6.9179E-002	2.8564E-004
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	2.5629E-002	4.0123E-008	2.8623E-002
Hf-182 [Details]	8.9000E+006	A	55-Ton Cask	NRF	3	West	1.1781E-003	1.2520E-005	1.1780E-005
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.9577E-008	7.6070E-007	
Kr-85 [Details]	1.0700E+001	S	55-Ton Cask	NRF	3	West	3.0366E-003	3.4951E-003	9.5207E-006
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.9099E-007	1.5450E-007	
Lu-176 [Details]	3.7700E+010	A	55-Ton Cask	NRF	3	West	4.9621E-008	1.7199E-009	4.9000E-008
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	7.7252E-007	3.3640E-009	3.2314E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	8.7625E-005	8.0353E-005	7.8838E-007
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	3.0478E-003	3.0000E-004	2.5747E-006
Pu-240 [Details]	6.5600E+003	S	55-Ton Cask	NRF	3	West	6.2508E-005	6.2150E-005	2.1013E-007
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.5554E-011	3.0640E-012	5.8100E-014
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.3667E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	2.0258E-007	1.0667E-007	5.4000E-014
Sr-90 [Details]	2.8900E+001	S	55-Ton Cask	NRF	3	West	8.2437E-002	6.9853E-002	2.7964E-004
Th-229 [Details]	7.8800E+003	A	55-Ton Cask	NRF	3	West	2.5886E-008	2.5884E-009	5.4054E-015
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.3966E-008	1.5922E-008	3.1528E-016
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	6.2605E-008	4.7761E-007	2.5402E-009
U-238 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	2.1776E-008	5.3827E-009	9.1691E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	4.5488E-008	7.1600E+005	4.3279E-009
Cd-113	A	NRF	3	2.4927E-023	7.7000E+015	2.3717E-024
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	9.9270E-008
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	1.1819E-007
H-3	S	NRF	3	1.3676E-006	1.2300E+001	1.3012E-007
Lu-173	A	NRF	3	6.3865E-003	1.3700E+000	6.0763E-004
Lu-174	A	NRF	3	5.8748E-002	3.3000E+000	5.5895E-003
Mn-53	A	NRF	3	2.1168E-008	3.7400E+006	2.0138E-009
Pb-210	A	NRF	3	4.3841E-015	2.2200E+001	4.1712E-016
Ra-228	S	NRF	3	4.7623E-013	5.7400E+000	4.5310E-014
Re-186m	A	NRF	3	2.0199E-007	2.0000E+005	1.9218E-008
Sm-147	S	NRF	3	3.8478E-015	1.0600E+011	3.6609E-016
Ta-179	A	NRF	3	7.7902E-004	1.8200E+000	7.4119E-005
Th-228	S	NRF	3	1.1408E-008	1.9100E+000	1.0854E-009
Th-229	S	NRF	3	1.6127E-012	7.8800E+003	1.5343E-013
Th-230	S	NRF	3	1.7624E-013	7.5400E+004	1.6768E-014
Tl-204	A	NRF	3	6.1557E-008	3.7700E+000	5.8568E-009

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nb-91	8.2666E-006	A	Yes
Nb-91m	1.4726E-020	A	Yes
Nd-144	4.4066E-024	S	Yes
Nd-144	4.4458E-026	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-122.

Of the remaining 20 radionuclides, 17 (Ac-227, Ar-39, Cm-245, Cm-246, Cs-137, Hf-178m, Hf-182, Kr-85, Lu-176, Pt-193, Pu-238, Ra-226, Rb-87, Sr-90, Th-229, Th-232, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the groundwater pathway dose[1] calculation during preparation of the PA. Ar-39 and Kr-85 were screened during Phase I because even though they have a half-life greater than 1 year, they are gases and will not contribute to the groundwater pathway dose or the intruder dose. The impacts from Ar-39 and Kr-85 on the air pathway are evaluated below. The cumulative inventories of the other 15 non-key groundwater pathway radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. Of the five key radionuclides, three (Np-237, Pu-240, and U-234) are key groundwater pathway radionuclides and are evaluated under PA Check 10 (see below). Cs-137 and Sr-90 are key intruder pathway radionuclides and are also evaluated under PA Check 10 (see below).

Groundwater Pathway

Of the 15 radionuclides screened from the groundwater pathway calculation during the PA Phase II and III screening, nine (Cm-245, Cm-246, Hf-178m, Lu-176, Pt-193, Ra-226, Rb-87, Th-229, and Th-232) were screened during Phase II, and the other six (Ac-227, Cs-137, Hf-182, Pu-238, Sr-90 and U-236) were screened during Phase III. Table 1 shows that except for Hf-178m, the projected cumulative inventories of the non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the projected cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-122) was added to the total PA base case inventory to obtain the projected cumulative inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-122 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each

[1] In the PA, the groundwater pathway dose is the same as the all-pathways dose.

non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the non-key radionuclides in ECF-01-21-122 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory (see Table 1, Column 8), the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated. According to the evaluation in UDQE-RHLLW-087, it would require 4E+39 Ci of Hf-178m to fail the PA Phase III screening criteria, and more than 30,000 Ci of Hf-178m to cause a significant intruder dose. Based on the projected cumulative Hf-178m inventory from Table 1 (2.86E-02 Ci), Hf-178m will have no impact on the conclusions of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Dose Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase II Screening Inventory
Cm-245	2.08E-10	2.85E-07	5.28E-07	8.13E-07	6.29E+04	6.36E-06	12.8%
Cm-246	8.32E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Hf-178m	2.86E-02	2.86E-02	4.01E-08	2.86E-02	9.25E+04	4.32E-06	662047%
Lu-176	4.98E-08	4.98E-08	7.76E-09	5.76E-08	3.18E+04	1.26E-05	0.46%
Pt-193	2.98E-07	9.76E-05	6.64E-04	7.62E-04	2.92E+02	1.37E-03	55.7%
Ra-226	5.81E-14	5.59E-11	3.14E-11	8.73E-11	2.96E+05	1.35E-06	0.0065%
Rb-87	5.40E-14	2.02E-07	1.28E-06	1.48E-06	4.44E+03	9.01E-05	1.65%
Th-229	5.41E-15	2.89E-08	5.35E-08	8.24E-08	1.18E+05	3.38E-06	2.44%
Th-232	3.15E-18	3.40E-08	2.48E-07	2.82E-07	3.66E+05	1.09E-06	25.8%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase III Screening Inventory
Ac-227	1.09E-12	3.06E-07	5.76E-06	6.07E-06	1.00E-40	2.30E+34	2.63E-38%
Cs-137	2.96E-04	8.09E-02	9.45E+02	9.45E+02	1.00E-40	3.78E+42	2.50E-38%
Hf-182	1.18E-03	1.18E-03	5.80E-05	1.24E-03	2.36E-06	9.83E+00	0.013%
Pu-238	2.57E-06	3.85E-03	3.68E-01	3.72E-01	2.57E-02	5.73E+00	6.49%
Sr-90	2.79E-04	8.24E-02	6.73E+02	6.73E+02	1.00E-40	2.69E+42	2.50E-38%
U-236	9.17E-12	2.18E-06	5.88E-05	6.10E-05	1.04E-02	2.26E-03	2.70%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018). Original reference is NCRP (1996).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Air Pathway
As previously stated, Ar-39 and Kr-85 were screened during Phase I of the air pathway screening. Here, the Ar-39 and Kr-85 inventories are evaluated to determine if the new cumulative inventory would still be screened from the air pathway. Air pathway screening is based on the total PA base case inventory of all generators. The total amount of Ar-39 evaluated in the PA is 3.24E-02 Ci. Canister ECF-01-21-122 contains 3.75E-4 Ci of Ar-39 and the cumulative amount thus far in all vault arrays is 5.31E-03 Ci, or 16.4% of the PA base case inventory (3.24E-02 Ci). The total amount of Kr-85 evaluated in the PA is 50.4 Ci. Canister ECF-01-21-122 contains 9.52E-06 Ci of Kr-85 and the cumulative amount thus far in all vault arrays is 3.84E-03 Ci (see Figure 1), or 0.008% of the PA base case inventory (50.4 Ci). The small additional amounts in canister ECF-01-21-122 is insignificant compared to the PA base case inventory and would not result in Ar-39 or Kr-85 being retained as a key air pathway radionuclide. Therefore, the Ar-39 and Kr-85 inventories in canister ECF-01-21-122 are within the bounds of the PA.

PA Check 10
Waste canister ECF-01-21-122 contains three key groundwater pathway radionuclides (Np-237, Pu-240, and U-234) and two key intruder pathway radionuclides (Cs-137, and Sr-90). The cumulative inventory of these radionuclides (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1).

The contributions of key groundwater pathway radionuclides are included in the RHINO all-pathways dose calculation. Key intruder pathway radionuclides are included in the RHINO intruder dose calculation. It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-122. The projected all-pathways dose after disposal of canister ECF-01-21-122 would increase by 0.00000007% for the compliance period and 0.11% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of canister ECF-01-21-122 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of waste canister ECF-01-21-122 would increase by 6.52%. and the total intruder dose is 0.231 mrem/yr. This is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario).

The increases in other performance measures are also small. The increase in the air pathway dose is 6.52%, and the projected dose of 1.61E-04 mrem/yr is much less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of some key radionuclides would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-01-21-122 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of proposed canister ECF-01-21-122.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister (mrem/yr)	Placed Canisters + Proposed Canister (mrem/yr)	% Increase in All-Pathways Dose After Placement of Proposed Canister
All Pathways Dose	Compliance	mrem/yr	1	25	9.03E-14	1.35E-04	0.00000007%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	8.75E-05	7.88E-02	0.11%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	6.41E-14	9.62E-05	0.00000007%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	9.63E-05	5.60E-02	0.17%
Ra-226/228	Compliance	pCi/L	0.2	5	1.44E-41	2.19E-32	0.00000007%

Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.14E-10	2.04E-06	0.006%
Gross Alpha	Compliance	pCi/L	0.6	15	1.77E-36	4.55E-30	0.000039%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	1.15E-09	6.37E-06	0.018%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	3.51E-14	5.26E-05	0.00000007%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	2.53E-05	3.06E-02	0.083%
Uranium	Compliance	ug/L	1.2	30	1.64E-33	8.88E-28	0.00018%
Uranium	Post-Compliance	ug/L	15	30	2.18E-08	1.69E-05	0.13%
Intruder	Compliance	mrem/yr	20	100	5.86E-03	2.31E-01	2.61%
Air Pathway	Compliance	mrem/yr	0.4	10	9.85E-06	1.61E-04	6.52%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-122 contains 17 unanalyzed radionuclide/waste form combinations with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these radionuclides when compared to the total canister inventory (1052 Ci) are much less than 1% (see Table 5, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[2]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Table 5 shows that 10 of the 17 radionuclide/waste form combinations were reported in other waste streams (Column 5, non-zero values). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory for these radionuclides (Column 2 ÷ Column 5) with the exception of Tl-204. This is evidence that these unanalyzed radionuclides in canister ECF-01-21-122 will not impact the conclusions of the PA. Tl-204 was evaluated further with the other radionuclides not reported in other waste streams.

Table 5. Unanalyzed radionuclides in waste canister ECF-01-21-122 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Proposed Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Al-26	4.55E-08	A	4.33E-09	N/A	N/A	N/A
Cd-113	2.49E-23	A	2.37E-24	N/A	N/A	N/A
Eu-152	1.04E-06	S	9.93E-08	4.14E+00	0.000025%	III
Eu-154	1.24E-06	S	1.18E-07	1.56E+01	0.0000080%	III
H-3	1.37E-06	S	1.30E-07	1.99E+03	0.000000069%	Retained
Lu-173	6.39E-03	A	6.08E-04	N/A	N/A	N/A
Lu-174	5.87E-02	A	5.59E-03	N/A	N/A	N/A

[2] Although the H-3 inventory is less than 1% of the total canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact is included in RHINO calculations (see PA Check 10). Therefore, H-3 does not need to be evaluated here.

Mn-53	2.12E-08	A	2.01E-09	N/A	N/A	N/A
Pb-210	4.38E-15	A	4.17E-16	2.89E-12	0.15%	II
Ra-228	4.76E-13	S	4.53E-14	2.28E-07	0.00021%	II
Re-186m	2.02E-07	A	1.92E-08	N/A	N/A	N/A
Sm-147	3.85E-15	S	3.66E-16	1.38E-10	0.0028%	II
Ta-179	7.79E-04	A	7.41E-05	N/A	N/A	N/A
Th-228	1.15E-08	S	1.09E-09	2.02E-04	0.0057%	III
Th-229	1.61E-12	S	1.53E-13	5.35E-08	0.0030%	II
Th-230	1.76E-13	S	1.68E-14	4.93E-08	0.00036%	II
Tl-204	6.16E-08	A	5.86E-09	1.10E-22	5.59E+16%	II

a. AM = Activated Metal, SC = surface contamination
b. Based on a total canister inventory of 1052 Ci (from RHINO).
N/A = Not Applicable. Not included in any base case PA waste streams.

Seven of the 17 unanalyzed radionuclide/waste form combinations were not reported in any other PA waste streams. These were evaluated further along with Tl-204. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subject to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 6), with the exception of Lu-173 and Lu-174, which are further analyzed below. The maximum PA Phase II screening inventory in Table 6 Column 6 is calculated using Equation 1. All of the remaining values in Column 7 are very small indicating these radionuclides would have been screened from the PA. As these and other unanalyzed radionuclides appear in future waste canisters, the same calculation will continue to be performed.

Table 6. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Total Facility Inventory of Previously Placed Canisters (Ci)	Sum of Proposed and Previously Placed Canisters (Ci)	NCRP Screening Dose Factor (mrem/Ci)[a]	Maximum Allowable Phase II Screening Inventory (Ci)	Sum of Proposed and Previously Placed Canisters Inventory as % of Max Allowable Phase II Screening Inventory
Al-26	4.55E-08	1.25E-07	1.70E-07	1.11E+05	3.60E-06	4.73%
Cd-113	2.49E-23	1.45E-21	1.48E-21	2.06E+05	1.94E-06	0.0000000000001%
Lu-173	6.39E-03	1.49E-05	6.40E-03	5.55E+02	7.21E-04	888%
Lu-174	5.87E-02	4.04E-06	5.88E-02	1.22E+03	3.28E-04	17934%
Mn-53	2.12E-08	1.08E-07	1.30E-07	1.67E+02	2.40E-03	0.0054%
Re-186m	2.02E-07	4.22E-08	2.44E-07	1.37E+04	2.92E-05	0.84%
Ta-179	7.79E-04	3.21E-05	8.11E-04	1.89E+02	2.12E-03	38.3%
Tl-204	6.16E-08	8.82E-26	6.16E-08	4.07E+02	9.83E-04	0.0063%

a. NCRP (1996).

<u>Impact of Lu-173 and Lu-174 on Groundwater All-Pathways Dose</u> – Lu-173 and Lu-174 were modeled using the PA Phase III screening model. A hypothetical inventory of 1 Ci was simulated, and the resulting dose was zero for both radionuclides. For the PA Phase III screening, all radionuclides that resulted in dose of zero were assigned a dose < 1E-40 mrem/yr. The low dose occurs because Lu-173 and Lu-174 have a large sorption coefficient (240 mL/gm) and short half-lives (1.37 years and 3.31 years, respectively). If the Lu-173 and Lu-174 doses from 1 Ci were 1E-40 mrem/yr, the maximum allowable Phase III inventory according to Equation 2 would be 4E+39 Ci (0.4 mrem/yr x 1 Ci/1E-40 mrem/yr).

Impact of Lu-173 and Lu-174 on the Intruder Dose – The inadvertent intruder screening in the PA considered all nuclides that failed the Phase II groundwater pathway screening. Based on the results in Table 6, the projected eventual Lu-173 and Lu-174 inventories would fail the PA Phase II screening and be subject to evaluation for the intruder pathway. The impact of Lu-173 and Lu-174 on the intruder pathway was determined by modeling these radionuclides using the same RESRAD computer model (Version 7.2, Yu et al. 2016) used for the PA inadvertent intruder analysis and the same calculations documented in ECAR-2073 (2018). The results in Table 7 show it would take 331,000 Ci of Lu-173 to cause an acute intruder dose of 500 mrem at 100 years (the PA total dose limit), and 6.11E+26 Ci of Lu-173 to cause a chronic intruder dose of 100 mrem/yr at 100 years (the PA total dose limit). Similarly, the results show it would take 324,000 Ci of Lu-174 to cause an acute intruder dose of 500 mrem at 100 years and 8.88E+13 Ci of Lu-174 to cause a chronic intruder dose of 100 mrem/yr at 100 years. 100 years is the time of maximum dose because it is assumed the facility will remain under institutional control for at least 100 years after closure.

According to Figure 1, canister ECF-01-21-122 would increase the cumulative Lu-173 inventory to 6.40E-03, which is 51 million times less than the maximum allowable. With the addition of Lu-174 in ECF-01-21-122, cumulative facility inventory would increase to 5.88E-02 Ci, which is approximately 5.1 million times less than the maximum allowable.

Table 7. Maximum Phase III dose in the acute and chronic intruder scenarios.

1	2	3	4	5	6
Radionuclide	Intruder Scenario	PA Maximum Total Intruder Dose[a]	PA Total Dose Limit	Dose-to-Source Ratio from RESRAD at 100 years[a,b]	Inventory Resulting in Dose of 500 mrem (Acute) and 100 mrem/yr (Chronic) at 100 years[a] (Ci)
Lu-173	Acute	3.19 mrem	500 mrem	1.35E-25 mrem per pCi/g	3.31E+05
	Chronic	5.42 mrem/yr	100 mrem/yr	2.60E-23 mrem/yr er pCi/g	6.11E+26
Lu-174	Acute	3.19 mrem	500 mrem	7.76E-13 mrem per pCi/g	3.24E+05
	Chronic	5.42 mrem/yr	100 mrem/yr	1.79E-10 mrem/yr per pCi/g	8.88E+13
a. Maximum doses in the PA occur at 100 years post-closure assuming the facility will remain under institutional control for at least 100 years after closure.					

Lu-173 and Lu-174 Summary – Based on the small impacts to the groundwater all-pathways dose and intruder dose from Lu-173 and Lu-174, there will be no impact on the conclusions of the PA.

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-122 contains three non-system radionuclides (Nb-91, Nb-91m, and Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 8 shows radionuclides Nb-91 and Nb-91m are listed as activated metal and Nd-144 is listed as both surface contamination and activated metal in canister ECF-01-21-122. The long half-life coupled with the very small inventory (< 1E-23 Ci) indicate Nd-144 will not have an impact on the PA. The inclusion of Nb-91m in waste canister ECF-01-21-122 would not affect the assumptions of the PA due to the very small inventory (3.48E-06 Ci) and short half-life (less than one year).

Nb-91 was previously identified as a non-system radionuclide in HFEF-5 waste canister MFC210277 (UDQE-RHLLW-053), and NRF 55-Ton waste canisters ECF-05-18-121 (UDQE-RHLLW-068), and ECF-05-18-122 (UDQE-RHLLW-075). In UDQE-RHLLW-053, the Nb-91 inventory was analyzed using the Phase III screening methodology from the PA. It was determined the RHLLW Disposal Facility could conservatively accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose limit criteria of 0.4 mrem/yr for the all-pathways dose. In other words, any amount less than this would be screened out by the PA Phase III screening criteria. The inventory of Nb-91 in canister ECF-01-21-122 is insignificant compared to 9E+16 Ci and will not impact the PA.

UDQE-RHLLW-053 also determined that the facility could accept up to 2.86E+04 Ci of Nb-91 and not exceed an acute intruder dose of 1 mrem, or 3.39E+04 Ci of Nb-91 and not exceed a chronic intruder dose of 1 mrem/yr. The PA dose limit is 500 mrem for the acute intruder scenario, and 100 mrem/yr for the chronic intruder scenario. The most limiting case is the chronic intruder scenario and the facility would be limited to 3.39E+06 Ci (33,900 mrem/Ci x 100 mrem) of Nb-91. Based on this the inventory of Nb-91 in waste canister ECF-01-21-122 combined with the total from other canisters emplaced in the facility is inconsequential with respect to potential impacts on the PA intruder dose.

Table 8. Non-system radionuclides in waste canister ECF-01-21-122.

Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Half-Life (years)
Nb-91	8.27E-06	A	6.80E+02
Nb-91m	1.47E-20	A	1.67E-01
Nd-144	4.41E-24	S	2.29E+15
Nd-144	4.45E-26	A	2.29E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-122 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

NCRP, 1996, *Screening Models for Releases of Radionuclides to Atmospheric, Surface Water, and Ground - Worksheets*, NCRP Report No. 123 II (Vol. 2), National Council on Radiation Protection and Measurement.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

UDQE-RHLLW-053, 2021, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-068, 2023, "Canister ECF-05-18-121 from NRF flagged by RHINO during PA checks," February 2023.

UDQE-RHLLW-075, 2023, "Canister ECF-05-18-122 from NRF flagged by RHINO during PA checks," August 2023.

UDQE-RHLLW-087, 2024, "Canister ECF-01-21-103 from NRF flagged by RHINO during PA checks," February 2024.

Jonathan Jacobson	Jonathan Jacobson	08/12/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
James Angell / Neal Russell	James Angell NEAL RUSSELL (Affiliate) Digitally signed by NEAL RUSSELL (Affiliate) Date: 2024.08.12 14:11:45 -06'00'	8/12/2024
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	08/12/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul A. Velasquez	Paul Velasquez	08/12/2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Tim Arsenault	8/12/24
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-102

Subject: Canister ECF-01-21-110 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-01-21-110 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-01-21-110 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 9 was flagged by RHINO because the cumulative inventories of 24 radionuclides Ac-227, Ar-39, Ce-142, Cm-245, Cm-246, Cs-137, Hf-178m, Hf-182, Ir-192m, Kr-85, La-137, Lu-176, Np-237, Pt-193, Pu-238, Pu-240, Ra-226, Ra-228, Rb-87, Sr-90, Th-229, Th-232, U-234, and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Nineteen of the 24 radionuclides flagged by PA Check 9 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 19 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The five key radionuclides flagged by RHINO (Cs-137, Np-237, Pu-240, Sr-90, and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA Check 10 was flagged by RHINO because the cumulative inventory of five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because the waste canister contains 8 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. RHINO also identified one non-system/non-exempt radionuclides in the waste canister. This radionuclide in these waste forms (activated metals and surface contamination) must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the proposed canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations,*

Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-01-21-110 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214, the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Kira Overin	Kira Overin	9/4/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault Timothy Arsenault (Sep 4, 2024 09:17 MDT)	Sep 4, 2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, and 12 by RHINO that occurred during the acceptance check of waste canister ECF-01-21-110. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

PA Check 9

The RHINO acceptance check for waste canister ECF-01-21-110 identified 24 radionuclides with half-lives greater than 1 year whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1). However, 14 radionuclides (Ac-227, Ar-39, Ce-142, Hf-178m, Hf-182, Ir-192m, La-137, Lu-176, Pt-193, Ra-226, Ra-228, Rb-87, Th-229, and Th-232) that were flagged by PA Checks 9 and 10 are not in canister ECF-01-21-110 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0). These radionuclides were evaluated under a previous UDQE, and do not need to be evaluated here.

Canister Details ECF-01-21-110

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	9/3/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	9/3/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	9/3/2024
	Yes	Beta-Gamma DE	5.5966E-002	2.4	mrem/yr	Post Compliance	9/3/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	9/3/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	9/3/2024
4	Yes	Gross Alpha	4.5491E-030	0.5	pCi/L	Compliance	9/3/2024
	Yes	Gross Alpha	6.3706E-006	7.5	pCi/L	Post Compliance	9/3/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	9/3/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	9/3/2024
6	Yes	Uranium	8.8788E-028	1.2	ug/L	Compliance	9/3/2024
	Yes	Uranium	1.6901E-005	15	ug/L	Post Compliance	9/3/2024
7	Yes	Intruder	2.5367E-001	20	mrem/yr	Compliance	9/3/2024
8	Yes	Air Pathway	1.7034E-004	0.4	mrem/yr	Compliance	9/3/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	9/3/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	9/3/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	9/3/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	9/3/2024
13	Yes	Canister Action Levels Check	-			Compliance	9/3/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in **bold**

Generator Facility: NRF
Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumulative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	3.0606E-007	2.0884E-007	
Ar-39 [Details]	2.6900E+002	A	55-Ton Cask	NRF	3	West	5.3492E-003	5.1109E-003	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	9.2910E-008	5.3156E-008	
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.8485E-007	6.9997E-008	1.3105E-010
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1632E-007	3.5211E-008	5.2428E-011
Cs-137 [Details]	3.0100E+001	S	55-Ton Cask	NRF	3	West	8.1210E-002	6.9179E-002	1.9879E-004
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	2.8629E-002	4.0123E-008	
Hf-182 [Details]	8.9000E+006	A	55-Ton Cask	NRF	3	West	1.1781E-003	1.2526E-005	
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.9677E-006	7.6070E-007	
Kr-85 [Details]	1.0700E+001	S	55-Ton Cask	NRF	3	West	3.8441E-003	3.4951E-003	6.3545E-006
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.9899E-007	1.5450E-007	
Lu-176 [Details]	3.7700E+010	A	55-Ton Cask	NRF	3	West	4.9822E-008	1.7199E-009	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	7.7236E-007	3.3543E-009	1.9715E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.7612E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	3.8505E-003	3.8098E-004	1.5428E-006
Pu-240 [Details]	6.5600E+003	S	55-Ton Cask	NRF	3	West	6.3128E-005	6.2158E-005	1.3214E-007
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.6039E-011	3.0840E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.3867E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	2.0238E-007	1.0867E-007	
Sr-90 [Details]	2.8900E+001	S	55-Ton Cask	NRF	3	West	8.2683E-002	6.9832E-002	1.8292E-004
Th-229 [Details]	7.8900E+003	A	55-Ton Cask	NRF	3	West	2.8895E-008	2.5084E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.3960E-008	1.5922E-008	
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	6.2717E-006	4.7751E-007	1.5840E-009
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	2.1770E-006	5.3927E-009	5.7531E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific.

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	1.1275E-006
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	1.3423E-006
H-3	S	NRF	3	1.3676E-006	1.2300E+001	1.4778E-006
Ra-228	S	NRF	3	2.7527E-013	5.7400E+000	2.9745E-013
Sm-147	S	NRF	3	2.3144E-015	1.0600E+011	2.5009E-015
Th-228	S	NRF	3	7.2886E-009	1.9100E+000	7.8759E-009
Th-229	S	NRF	3	8.9380E-013	7.8900E+003	9.6582E-013
Th-230	S	NRF	3	9.7037E-014	7.5400E+004	1.0486E-013

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	2.8078E-024	S	Yes
Nd-144	1.4867E-023	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-01-21-110.

Of the remaining 10 radionuclides, 5 (Cm-245, Cm-246, Kr-85, Pu-238, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the groundwater pathway dose[1] calculation during preparation of the PA. Kr-85 was screened during Phase I because even though it has a half-life greater than 1 year, it is a gas and will not contribute to the groundwater pathway dose or the intruder dose. The impact from Kr-85 on the air pathway is evaluated below. The cumulative inventories of the other 4 non-key groundwater pathway radionuclides will be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. Of the five key radionuclides, three (Np-237, Pu-240, and U-234) are key groundwater pathway radionuclides and are evaluated under PA Check 10 (see below). Cs-137 and Sr-90 are key intruder pathway radionuclides and are also evaluated under PA Check 10 (see below).

Groundwater Pathway

Of the 6 radionuclides screened from the groundwater pathway calculation during the PA Phase II and III screening, two (Cm-245 and Cm-246) were screened during Phase II, and the other four (Cs-137, Pu-238, Sr-90 and U-236) were screened during Phase III. Table 1 shows that the projected cumulative inventories of the non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the projected cumulative inventory (after disposal of the proposed canister) of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-01-21-110) was added to the total PA base case inventory to obtain the projected cumulative inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x\ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-01-21-110 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III

[1] In the PA, the groundwater pathway dose is the same as the all-pathways dose.

screening inventories (Column 7) and would still be screened out. Thus, the inventories of the non-key radionuclides in ECF-01-21-110 are within the bounds of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Dose Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase II Screening Inventory
Cm-245	1.31E-10	2.85E-07	5.28E-07	8.13E-07	6.29E+04	6.36E-06	12.8%
Cm-246	5.24E-11	1.16E-07	3.52E-07	4.68E-07	3.00E+04	1.33E-05	3.51%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase III Screening Inventory
Cs-137	1.99E-04	8.12E-02	9.45E+02	9.45E+02	1.00E-40	3.78E+42	2.50E-38%
Pu-238	1.84E-06	3.85E-03	3.68E-01	3.72E-01	2.57E-02	5.73E+00	6.49%
Sr-90	1.83E-04	8.27E-02	6.73E+02	6.73E+02	1.00E-40	2.69E+42	2.50E-38%
U-236	5.75E-12	2.18E-06	5.88E-05	6.10E-05	1.04E-02	2.26E-03	2.70%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018). Original reference is NCRP (1996).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Air Pathway

As previously stated, Kr-85 was screened during Phase I of the air pathway screening. Here, the Kr-85 inventory is evaluated to determine if the new cumulative inventory would still be screened from the air pathway. Air pathway screening is based on the total PA base case inventory of all generators. The total amount of Kr-85 evaluated in the PA is 50.4 Ci. Canister ECF-01-21-110 contains 6.35E-06 Ci of Kr-85 and the cumulative amount thus far in all vault arrays is 3.84E-03 Ci (see Figure 1), or 0.008% of the PA base case inventory (50.4 Ci). The small additional amounts in canister ECF-01-21-110 is insignificant compared to the PA base case inventory and would not result in Kr-85 being retained as a key air pathway radionuclide. Therefore, the Kr-85 inventory in canister ECF-01-21-110 is within the bounds of the PA.

PA Check 10

Waste canister ECF-01-21-110 contains three key groundwater pathway radionuclides (Np-237, Pu-240, and U-234) and two key intruder pathway radionuclides (Cs-137, and Sr-90). The cumulative inventory of these radionuclides (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1).

The contributions of key groundwater pathway radionuclides are included in the RHINO all-pathways dose calculation. Key intruder pathway radionuclides are included in the RHINO intruder dose calculation. It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-01-21-110. The projected all-pathways dose after disposal of canister ECF-01-21-110 would increase by 0.00000005% for the compliance period and 0.06% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of canister ECF-01-21-110 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of waste canister ECF-01-21-110 would increase by 0.28%. and the total intruder dose is 0.254 mrem/yr. This is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario).

The increases in other performance measures are also small. The increase in the air pathway dose is 3.75%, and the projected dose of 1.70E-04 mrem/yr is much less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of some key radionuclides would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-01-21-110 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of proposed canister ECF-01-21-110.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister (mrem/yr)	Placed Canisters + Proposed Canister (mrem/yr)	% Increase in All-Pathways Dose After Placement of Proposed Canister
All Pathways Dose	Compliance	mrem/yr	1	25	6.20E-14	1.35E-04	0.00000005%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	5.07E-05	7.88E-02	0.06%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	4.40E-14	9.62E-05	0.00000005%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	1.74E-05	5.60E-02	0.03%
Ra-226/228	Compliance	pCi/L	0.2	5	8.37E-42	2.19E-32	0.00000004%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	1.01E-10	2.04E-06	0.005%
Gross Alpha	Compliance	pCi/L	0.6	15	1.17E-37	4.55E-30	0.000003%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	2.22E-10	6.37E-06	0.003%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	2.41E-14	5.26E-05	0.00000005%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	1.48E-05	3.06E-02	0.048%
Uranium	Compliance	ug/L	1.2	30	1.06E-34	8.88E-28	0.00001%
Uranium	Post-Compliance	ug/L	15	30	2.47E-08	1.69E-05	0.15%
Intruder	Compliance	mrem/yr	20	100	6.98E-04	2.54E-01	0.28%
Air Pathway	Compliance	mrem/yr	0.4	10	6.16E-06	1.70E-04	3.75%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-01-21-110 contains 8 unanalyzed radionuclide/waste form combinations with half-lives greater than one year. These radionuclides in this particular waste form (surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these radionuclides when compared to the total canister inventory (92.5 Ci) are much less than 1% (see Table 5, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[2]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total projected PA base case inventories of all waste forms from all generators.

Table 3 shows that all 8 of the radionuclide/waste form combinations were reported in other waste streams (Column 5, non-zero values). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory for these radionuclides (Column 2 ÷ Column 5). This is evidence that these unanalyzed radionuclides in canister ECF-01-21-110 will not impact the conclusions of the PA.

Table 3. Unanalyzed radionuclides in waste canister ECF-01-21-110 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Proposed Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Eu-152	1.04E-06	SC	1.13E-06%	4.14E+00	0.00003%	III
Eu-154	1.24E-06	SC	1.34E-06%	1.56E+01	0.00001%	III
H-3	1.37E-06	SC	1.48E-06%	1.99E+03	0.00000007%	Retained
Ra-228	2.75E-13	SC	2.97E-13%	2.28E-07	0.0001%	II
Sm-147	2.31E-15	SC	2.50E-15%	1.38E-10	0.002%	II
Th-228	7.29E-09	SC	7.88E-09%	2.02E-04	0.004%	III
Th-229	8.94E-13	SC	9.66E-13%	5.35E-08	0.002%	II
Th-230	9.70E-14	SC	1.05E-13	4.93E-08	0.0002%	II

a. SC = surface contamination
b. Based on a total canister inventory of 92.5 Ci (from RHINO).

Non-system Radionuclides

Figure 1 shows waste canister ECF-01-21-110 contains one non-system radionuclides (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 8 shows radionuclide Nd-144 is listed as both surface contamination and activated metal in canister ECF-01-21-110. The long half-life coupled with the very small inventory (< 1E-23 Ci) indicate Nd-144 will not have an impact on the PA.

Table 4. Non-system radionuclides in waste canister ECF-01-21-110.

Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Half-Life (years)
Nd-144	2.81E-24	S	2.29E+15
Nd-144	1.49E-23	A	2.29E+15

a. AM = Activated Metal, SC = surface contamination

Summary

The radionuclide inventory of waste canister ECF-01-21-110 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

[2] Although the H-3 inventory is less than 1% of the total canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact is included in RHINO calculations (see PA Check 10). Therefore, H-3 does not need to be evaluated here.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

NCRP, 1996, *Screening Models for Releases of Radionuclides to Atmospheric, Surface Water, and Ground - Worksheets*, NCRP Report No. 123 II (Vol. 2), National Council on Radiation Protection and Measurement.

PLN-5446, 2022, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, December 2022.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson Jonathan Jacobson (Sep 4, 2024 11:34 MDT) Originator/FDS	Sep 4, 2024
James Angell Neal Russell System Engineer/SE	James Angell Neal Russell James Angell (Sep 4, 2024 14:44 MDT) Neal Russell (Sep 4, 2024 14:54 MDT) System Engineer/SE	Sep 4, 2024
A. Jeff Sondrup PA/CA SME	A. Jeff Sondrup A. Jeff Sondrup (Sep 4, 2024 08:18 MDT) PA/CA SME	Sep 4, 2024
Paul Velasquez Waste Management/WMP	Paul Velasquez Waste Management/WMP	Sep 4, 2024
Timothy Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault Timothy Arsenault (Sep 4, 2024 09:17 MDT) Nuclear Facility Manger/NFM	Sep 4, 2024

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

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Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UDQE Tracking No.: UDQE-RHLLW-103

Subject: Canister ECF-05-18-109 from NRF flagged by RHINO during PA checks

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

Waste canister ECF-05-18-109 is a 55-Ton waste canister containing activated metals and surface contaminated debris from Naval Reactors Facility (NRF). Prior to shipment the waste canister details are entered into the RHLLW Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Canister ECF-05-18-109 was flagged by RHINO based on the following inventory checks:

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
Performance Assessment (PA) Check 9 was flagged by RHINO because the cumulative inventories of 27 radionuclides (Ac-227, Ar-39, Ce-142, Cf-249, Cf-252, Cm-245, Cm-246, Cm-248, Cs-137, Hf-178m, Hf-182, Ir-192m, Kr-85, La-137, Lu-176, Np-237, Pt-193, Pu-238, Pu-240, Ra-226, Ra-228, Rb-87, Sr-90, Th-229, Th-232, U-234 and U-236) with half-lives greater than 1 year exceed the PA base case inventories for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. Twenty-two of the 27 radionuclides flagged by PA Check 9 are considered "non-key" radionuclides because they were screened out of the all-pathway dose calculation during preparation of the PA. The 22 non-key radionuclides must be evaluated to determine if the increased inventory (above the PA base case) would have resulted in the radionuclide not being screened out during completion of the PA. The five key radionuclides flagged by RHINO (Cs-137, Np-237, Pu-240, Sr-90 and U-234) are addressed under PA Check 10 (see below).

PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
PA Check 10 was flagged by RHINO because the cumulative inventory of five key radionuclides (Cs-137, Np-237, Pu-240, Sr-90 and U-234) exceed the PA base-case inventory for this specific generator (NRF), waste form (activated metals with surface contaminated debris) and canister type (55-Ton). The cumulative inventory includes the inventory of previously emplaced canisters plus the proposed canister. The inventory of these key radionuclides must be evaluated to determine if the increased inventory and accompanying dose is within the bounds of the PA.

PA Check 12: Non-system/Unanalyzed/Non-exempt Nuclides Check
This flag was checked by RHINO because the waste canister contains 11 unanalyzed radionuclides with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the Waste Acceptance Criteria (WAC) (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. RHINO also identified one non-system/non-exempt radionuclide in the waste canister. Non-system/non-exempt radionuclides must be evaluated to confirm the inventories will not impact the conclusions of the PA.

Exceedance of a threshold value flagged by RHINO does not indicate the proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed. If after review, it is determined the inventory levels (both canister and cumulative) are within the bounds of the approved PA, the canister may be approved for disposal.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has* ***de minimus*** *contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☒ No ☐

Comments: Canister ECF-05-18-109 was flagged by RHINO while performing PA checks of the waste canister inventory. According to RH-ADM-5214 (2024), the radionuclide activities must be evaluated to confirm they are within the bounds of the approved PA, or will not impact the conclusions of the PA.

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

A. Jeff Sondrup	Jeff Sondrup	09/18/2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault Timothy Arsenault (Sep 18, 2024 12:34 MDT)	Sep 18, 2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required

This explanation contains an evaluation of flagged PA Checks 9, 10, and 12 by RHINO that occurred during the acceptance check of waste canister ECF-05-18-109. Figure 1 shows the canister details page from RHINO and the results of the PA check. Evaluations of each canister check flagged by RHINO are contained below.

PA Check 9

The RHINO acceptance check for waste canister ECF-05-18-109 identified 27 radionuclides with half-lives greater than 1 year whose cumulative inventories (includes placed canisters + the proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1)[1]. However, eleven radionuclides (Ac-227, Ar-39, Ce-142, Ir-192m, La-137, Lu-176, Pt-193, Ra-226, Ra-228, Rb-87, and Th-229) that were flagged by PA Checks 9 and 10 are not in canister ECF-05-18-109 (see Figure 1, last column of PA Checks 9 & 10, Canister Contribution = 0). These radionuclides were evaluated under a previous UDQE, and do not need to be evaluated here.

[1] There are 29 entries under PA Check 9 and 10 in Figure 1, but Cm-245 and Cm-246 are listed twice because they were identified in both the activated metal (A), and surface contamination (S) waste forms. Thus there are only 27 radionuclides identified.

Canister Details ECF-05-18-109

Canister Details | Nuclides | Rad Readings | PA Check | WAC Check | References | Attachments | Images

PA Status: Fail | Placement Vault: 55-Ton Cask

PA Results

No.	Pass	Performance Measure	Value	Limit	Units	Type	Run Date
1	Yes	All Pathways Dose	1.3538E-004	1	mrem/yr	Compliance	9/3/2024
	Yes	All Pathways Dose	7.8836E-002	12.5	mrem/yr	Post Compliance	9/3/2024
2	Yes	Beta-Gamma DE	9.6157E-005	0.16	mrem/yr	Compliance	9/3/2024
	Yes	Beta-Gamma DE	5.5908E-002	2.4	mrem/yr	Post Compliance	9/3/2024
3	Yes	Ra-226/228	2.1880E-032	0.2	pCi/L	Compliance	9/3/2024
	Yes	Ra-226/228	2.0426E-006	2.5	pCi/L	Post Compliance	9/3/2024
4	Yes	Gross Alpha	4.5491E-030	0.6	pCi/L	Compliance	9/3/2024
	Yes	Gross Alpha	6.3706E-006	7.5	pCi/L	Post Compliance	9/3/2024
5	Yes	Beta-Gamma ED	5.2609E-005	0.16	mrem/yr	Compliance	9/3/2024
	Yes	Beta-Gamma ED	3.0619E-002	2	mrem/yr	Post Compliance	9/3/2024
6	Yes	Uranium	8.6788E-020	1.2	ug/L	Compliance	9/3/2024
	Yes	Uranium	1.6001E-005	15	ug/L	Post Compliance	9/3/2024
7	Yes	Intruder	2.5314E-001	20	mrem/yr	Compliance	9/3/2024
8	Yes	Air Pathway	1.6873E-004	0.4	mrem/yr	Compliance	9/3/2024
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	9/3/2024
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	9/3/2024
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	9/3/2024
12	No	Non-System/Unanalyzed/Non-Exempt Nuclides Check	-			Compliance	9/3/2024
13	Yes	Canister Action Levels Check	-			Compliance	9/3/2024

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form (Half Life > 1 Year)

Note: Nuclides of interest are in bold

Generator Facility: NRF | Array: All

Nuclide	Half Life	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contibution (Ci)
Ac-227 [Details]	2.1800E+001	A	55-Ton Cask	NRF	3	West	3.0606E-007	2.0884E-007	
Ar-39 [Details]	2.6900E+002	A	55-Ton Cask	NRF	3	West	5.3460E-003	5.1109E-003	
Ce-142 [Details]	5.0100E+016	A	55-Ton Cask	NRF	3	West	9.2910E-008	5.3195E-008	
Cf-249 [Details]	3.5200E+002	A	55-Ton Cask	NRF	3	West	1.0805E-011	3.2872E-013	1.0765E-011
Cf-252 [Details]	2.6500E+000	A	55-Ton Cask	NRF	3	West	2.6130E-010	2.4844E-011	2.6130E-010
Cm-245 [Details]	8.4900E+003	A	55-Ton Cask	NRF	3	West	3.2125E-007	8.3190E-008	2.0910E-007
Cm-245 [Details]	8.4900E+003	S	55-Ton Cask	NRF	3	West	2.0480E-007	6.9997E-008	8.0176E-011
Cm-246 [Details]	4.7500E+003	A	55-Ton Cask	NRF	3	West	1.9603E-007	5.0314E-008	1.9196E-007
Cm-246 [Details]	4.7500E+003	S	55-Ton Cask	NRF	3	West	1.1630E-007	3.5211E-008	3.2021E-011
Cm-248 [Details]	3.4900E+005	A	55-Ton Cask	NRF	3	West	8.6926E-015	1.0675E-015	8.6059E-015
Cs-137 [Details]	3.0100E+001	S	55-Ton Cask	NRF	3	West	8.1142E-002	6.9179E-002	1.3127E-004
Hf-178m [Details]	3.1000E+001	A	55-Ton Cask	NRF	3	West	2.8830E-002	4.0123E-008	6.0574E-007
Hf-182 [Details]	8.9000E+006	A	55-Ton Cask	NRF	3	West	1.1763E-003	1.2520E-005	1.5485E-007
Ir-192m [Details]	2.4100E+002	A	55-Ton Cask	NRF	3	West	1.9577E-006	7.6079E-007	
Kr-85 [Details]	1.0700E+001	S	55-Ton Cask	NRF	3	West	3.0416E-003	3.4951E-003	3.9387E-006
La-137 [Details]	5.9900E+004	A	55-Ton Cask	NRF	3	West	4.9808E-007	1.5458E-007	
Lu-176 [Details]	3.7700E+010	A	55-Ton Cask	NRF	3	West	4.9822E-008	1.7199E-009	
Np-237 [Details]	2.1500E+006	S	55-Ton Cask	NRF	3	West	7.7236E-007	3.3843E-009	1.1088E-011
Pt-193 [Details]	5.0100E+001	A	55-Ton Cask	NRF	3	West	9.7612E-005	8.0353E-005	
Pu-238 [Details]	8.7800E+001	S	55-Ton Cask	NRF	3	West	3.8500E-003	3.8088E-004	1.3504E-006
Pu-240 [Details]	6.5600E+003	S	55-Ton Cask	NRF	3	West	6.3077E-005	6.2158E-005	8.0826E-008
Ra-226 [Details]	1.6000E+003	A	55-Ton Cask	NRF	3	West	5.6039E-011	3.0040E-012	
Ra-228 [Details]	5.7400E+000	A	55-Ton Cask	NRF	3	West	3.3867E-008	1.9187E-008	
Rb-87 [Details]	4.8200E+010	A	55-Ton Cask	NRF	3	West	2.0236E-007	1.0667E-007	
Sr-90 [Details]	2.8800E+001	S	55-Ton Cask	NRF	3	West	8.2616E-002	6.0832E-002	1.1588E-004
Th-229 [Details]	7.8800E+003	A	55-Ton Cask	NRF	3	West	2.0895E-008	2.5004E-009	
Th-232 [Details]	1.4000E+010	A	55-Ton Cask	NRF	3	West	3.3960E-008	1.5022E-008	3.1441E-019
U-234 [Details]	2.4600E+005	S	55-Ton Cask	NRF	3	West	6.2711E-006	4.7761E-007	9.6496E-010
U-236 [Details]	2.3400E+007	S	55-Ton Cask	NRF	3	West	2.1770E-006	5.3927E-009	3.4948E-012

Canister Specific Test Details

Note: Tests 11-13 are canister specific

12. PA Unanalyzed Nuclides with a half-life > 1 year (Canister Specific)

Nuclide	Form	Generator	Array	Amount (Ci)	Half Life (y)	% Canister Activity
Al-26	A	NRF	3	4.5790E-010	7.1600E+005	2.6602E-010
Cd-113	A	NRF	3	1.0699E-021	7.7000E+015	6.2159E-022
Eu-152	S	NRF	3	1.0434E-006	1.3500E+001	6.0617E-007
Eu-154	S	NRF	3	1.2422E-006	8.5900E+000	7.2169E-007
H-3	S	NRF	3	1.3676E-006	1.2300E+001	7.9454E-007
Ra-228	S	NRF	3	1.4061E-013	5.7400E+000	8.1691E-014
Re-186m	A	NRF	3	6.1369E-008	2.0000E+005	3.5653E-008
Sm-147	S	NRF	3	1.3899E-015	1.0600E+011	8.0747E-016
Th-228	S	NRF	3	4.4371E-009	1.9100E+000	2.5778E-009
Th-229	S	NRF	3	5.2473E-013	7.8800E+003	3.0485E-013
Th-230	S	NRF	3	5.7319E-014	7.5400E+004	3.3300E-014

12. Non-System/Non-Exempt Nuclides (Canister Specific)

Nuclide	Amount	Type	Imported as (Ci)
Nd-144	1.7096E-024	S	Yes
Nd-144	1.1409E-021	A	Yes

Figure 1. PA Check output screen from RHINO for waste canister ECF-05-18-109.

Of the remaining 16 radionuclides, 13 (Cf-249, Cf-252, Cm-245, Cm-246, Cm-248, Cs-137, Hf-178m, Hf-182, Kr-85, Pu-238, Sr-90, Th-232, and U-236) are considered "non-key" radionuclides for the groundwater pathway because they were screened out of the groundwater pathway dose[2] calculation during preparation of the PA. Kr-85 was screened during Phase I because even though it has a half-life greater than 1 year, it is a gas and will not contribute to the groundwater pathway dose or the intruder dose. The impact of Kr-85 on the air pathway is evaluated below. The cumulative inventories of the other 12 non-key groundwater pathway radionuclides are evaluated below to determine if the increased inventory (above the PA base case) would have resulted in the radionuclides not being screened from the groundwater pathway during preparation of the PA. Of the five key radionuclides identified, three (Np-237, Pu-240, and U-234) are key groundwater pathway radionuclides and are evaluated under PA Check 10 (see below). Cs-137 and Sr-90 are key intruder pathway radionuclides and are also evaluated under PA Check 10 (see below).

Groundwater Pathway

Of the 12 radionuclides screened from the groundwater pathway calculation during the PA Phase II and III screening, seven (Cf-249, Cf-252, Cm-245, Cm-246, Cm-248, Hf-178m, and Th-232) were screened during Phase II, and the other five (Cs-137, Hf-182, Pu-238, Sr-90 and U-236) were screened during Phase III. Table 1 shows that except for Hf-178m, the projected cumulative inventories of the non-key radionuclides would still be screened out using the Phase II and III screening criteria of the PA. This was done by calculating the projected cumulative inventory of each radionuclide as a percentage of the maximum allowable inventory allowed by the PA Phase II and III groundwater pathway screenings. For this calculation the inventory of all placed canisters plus the proposed canister (ECF-05-18-109) was added to the total PA base case inventory to obtain the projected cumulative inventory. This is conservative because the PA base case inventories likely include some of the inventory in the placed and proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form.

The maximum allowable inventory allowed by the Phase II screening ($Imax_{IIi}$) was calculated using the following equation:

$$Imax_{II_i}\left(\frac{Ci}{yr}\right) = \frac{0.4\left(\frac{mrem}{yr}\right)}{NCRP\ Screening\ Dose_i\left(\frac{mrem}{Ci}\right)} \quad \text{(Equation 1)}$$

where:

0.4 mrem/yr = PA Phase II screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters). This assumes the entire inventory is leached from the source in one year.

NCRP Screening Dose Factor (mrem/Ci) (see DOE-ID 2018, Table 2-26).

The maximum allowable inventory allowed by the Phase III screening ($Imax_{III_i}$) was calculated using the following equation:

$$Imax_{III_i}(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \ \frac{I_{PA_i}(Ci)}{D_{III_i}\left(\frac{mrem}{yr}\right)} \quad \text{(Equation 2)}$$

where:

0.4 mrem/yr = PA Phase III screening dose standard (1/10th the allowable 40 CFR 141 drinking water dose for beta-gamma emitters)

I_{PAi} = total PA base case inventory of radionuclide i (see DOE-ID 2018, Table 2-29)

D_{IIIi} = PA Phase III screening dose for radionuclide i based on total PA base case inventory of radionuclide i.

Table 1 shows that even when the projected cumulative inventory after placement of canister ECF-05-18-109 (Column 3) and the total PA base case inventory (Column 4) are conservatively summed together for each non-key radionuclide, the totals (Column 5) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 7) and would still be screened out except for Hf-178m. Thus, the inventories of the

[2] In the PA, the groundwater pathway dose is the same as the all-pathways dose.

non-key radionuclides in ECF-05-18-109 are within the bounds of the PA with the potential exception of Hf-178m which is evaluated below.

Because the sum of the cumulative inventory and the PA base case inventory of Hf-178m exceeds the maximum allowable Phase II screening inventory (see Table 1, Column 8), the potential impacts of Hf-178m on the groundwater all-pathways dose and the intruder dose were evaluated. According to the evaluation in UDQE-RHLLW-087, it would require 4E+39 Ci of Hf-178m to fail the PA Phase III screening criteria, and more than 30,000 Ci of Hf-178m to cause a significant intruder dose. Based on the projected cumulative Hf-178m inventory from Table 1 (2.86E-02 Ci), Hf-178m will have no impact on the conclusions of the PA.

Table 1. Comparison of non-key radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7	8
Non-key Radionuclides Screened During PA Phase II Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase II NCRP Screening Dose Factor (mrem/Ci)[c]	Max Allowable Phase II Screening Inventory (Ci/yr)[d]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase II Screening Inventory
Cf-249	1.08E-11	1.08E-11	3.71E-12	1.45E-11	5.55E+04	7.21E-06	0.0002%
Cf-252	2.61E-10	2.61E-10	9.90E-11	3.60E-10	1.30E+03	3.09E-04	0.0001%
Cm-245	2.89E-07	6.06E-07	5.28E-07	1.13E-06	6.29E+04	6.36E-06	18%
Cm-246	1.92E-07	3.13E-07	3.52E-07	6.65E-07	3.00E+04	1.33E-05	5.0%
Cm-248	8.69E-15	8.69E-15	5.18E-13	5.27E-13	1.11E+05	3.60E-06	0.00001%
Hf-178m	6.06E-07	2.86E-02	4.01E-08	2.86E-02	9.25E+04	4.32E-06	662070%
Th-232	3.14E-19	3.40E-08	2.48E-07	2.82E-07	3.66E+05	1.09E-06	26%
Non-key Radionuclides Screened During PA Phase III Groundwater Pathway Screening							
Non-Key Radionuclide	Proposed Canister Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Canister + Total PA Base Case Inventory (Cols 3+4) (Ci)	PA Phase III Screening Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of Proposed Canister as % of Max Allowable Phase III Screening Inventory
Cs-137	1.31E-04	8.11E-02	9.45E+02	9.45E+02	1.00E-40	3.78E+42	2.5E-38%
Hf-182	1.55E-07	1.18E-03	5.80E-05	1.24E-03	2.36E-06	9.83E+00	0.01%
Pu-238	1.35E-06	3.85E-03	3.68E-01	3.72E-01	2.57E-02	5.73E+00	6.5%
Sr-90	1.16E-04	8.26E-02	6.73E+02	6.73E+02	1.00E-40	2.69E+42	2.5E-38%
U-236	3.49E-12	2.18E-06	5.88E-05	6.10E-05	1.04E-02	2.26E-03	2.7%

a. Inventory of activated metal and surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
c. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018). Original reference is NCRP (1996).
d. $Imax_{II}$ from Equation 1 above.
e. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018). Doses < 1E-40 mrem/yr are assumed = 1E-40 mrem/yr.
f. $Imax_{III}$ from Equation 2 above.

Air Pathway
As previously stated, Kr-85 was screened during Phase I of the air pathway screening. Here, the Kr-85 inventory was evaluated to determine if the new cumulative inventory would still be screened from the air pathway. Air pathway screening is based on the total PA base case inventory of all generators. The total amount of Kr-85 evaluated in the PA is 50.4 Ci. Canister ECF-05-18-109 contains 3.94E-06 Ci of Kr-85 and the cumulative amount thus far in all vault arrays is 3.84E-03 Ci (see Figure 1), or 0.008% of the PA base case inventory (50.4 Ci). The small additional amount in canister ECF-05-18-109 is insignificant compared to the PA base case inventory and would not result in Kr-85 being retained as a key air pathway radionuclide. Therefore, the Kr-85 inventory in canister ECF-05-18-109 is within the bounds of the PA.

PA Check 10
Waste canister ECF-05-18-109 contains three key groundwater pathway radionuclides (Np-237, Pu-240, and U-234) and two key intruder pathway radionuclides (Cs-137, and Sr-90). The cumulative inventory of these radionuclides (includes placed + proposed canister) exceed the PA base-case inventories for this generator (NRF), canister type (55-Ton) and waste form (combined activated metals with surface contaminated debris) (see Figure 1).

The contributions of key groundwater pathway radionuclides are included in the RHINO all-pathways dose calculation. Key intruder pathway radionuclides are included in the RHINO intruder dose calculation. It is allowable for the proposed cumulative inventory of a radionuclide to exceed the PA base-case inventory for a specific generator/canister/waste form so long as the impact of the proposed cumulative inventory is within the bounds of the PA. This is demonstrated by calculating the projected impacts on PA performance measures from placement of the proposed canister. Table 2 shows the impact on PA performance measures from placement of canister ECF-05-18-109. The projected all-pathways dose after disposal of canister ECF-05-18-109 would increase by 0.00000003% for the compliance period and 0.13% for the post-compliance period. These are very small increases and the all-pathways dose after disposal of canister ECF-05-18-109 is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The projected intruder dose after disposal of waste canister ECF-05-18-109 would increase by 0.07%. and the total intruder dose is 0.253 mrem/yr. This is significantly less than the PA limit of 100 mrem/yr (chronic intruder drilling scenario).

The increases in other performance measures are also small. The increase in the air pathway dose is 2.8%, and the projected dose of 1.69E-04 mrem/yr is much less than the performance measure of 10 mrem/yr from all sources. Moreover, the increase in the air pathway dose is due to other radionuclides (C-14, H-3, and I-129) whose cumulative inventories are less than the PA base case values. Thus, this evaluation shows that although the cumulative inventories of some key radionuclides would exceed the PA base case inventory for this generator/canister/waste form, the impact from disposal of canister ECF-05-18-109 on PA performance measures is small and within the bounds of the PA.

Table 2. Impact on performance measures from placement of proposed canister ECF-05-18-109.

1	2	3	4	5	7	8	9
Performance Measure	Period	Units	Project Limit	PA Limit	Proposed Canister (mrem/yr)	Placed Canisters + Proposed Canister (mrem/yr)	% Increase in All-Pathways Dose After Placement of Proposed Canister
All Pathways Dose	Compliance	mrem/yr	1	25	4.32E-14	1.35E-04	0.00000003%
All Pathways Dose	Post-Compliance	mrem/yr	12.5	25	9.91E-05	7.88E-02	0.13%
Beta-Gamma DE	Compliance	mrem/yr	0.16	4	3.06E-14	9.62E-05	0.00000003%
Beta-Gamma DE	Post-Compliance	mrem/yr	2.4	4	3.40E-05	5.60E-02	0.06%
Ra-226/228	Compliance	pCi/L	0.2	5	1.29E-41	2.19E-32	0.00000006%
Ra-226/228	Post-Compliance	pCi/L	2.5	5	2.24E-10	2.04E-06	0.011%
Gross Alpha	Compliance	pCi/L	0.6	15	1.99E-36	4.55E-30	0.00004%
Gross Alpha	Post-Compliance	pCi/L	7.5	15	1.66E-09	6.37E-06	0.03%
Beta-Gamma ED	Compliance	mrem/yr	0.16	4	1.68E-14	5.26E-05	0.00000003%
Beta-Gamma ED	Post-Compliance	mrem/yr	2	4	2.89E-05	3.06E-02	0.09%
Uranium	Compliance	ug/L	1.2	30	1.84E-33	8.88E-28	0.0002%
Uranium	Post-Compliance	ug/L	15	30	5.66E-08	1.69E-05	0.34%
Intruder	Compliance	mrem/yr	20	100	1.66E-04	2.53E-01	0.07%
Air Pathway	Compliance	mrem/yr	0.4	10	4.55E-06	1.69E-04	2.8%

PA Check 12

Unanalyzed Radionuclides with Half-lives Greater than 1 Year

Figure 1 shows waste canister ECF-05-18-109 contains 11 unanalyzed radionuclide/waste form combinations with half-lives greater than one year. These radionuclides in these particular waste forms (activated metals and surface contamination) were not reported in the PA base-case inventory for this generator (NRF) and canister type (55-Ton), and thus were not analyzed in the PA [see Table B-6 in the WAC (PLN-5446) for list of analyzed radionuclides by waste form for 55-ton canisters]. Therefore, they must be analyzed to confirm the inventories are within the bounds of the PA.

The majority of the individual inventories of these radionuclides when compared to the total canister inventory (172 Ci) are much less than 1% (see Table 3, Column 4). Therefore, the inventory of these radionuclides are not reportable according to the WAC with the exception of H-3[3]. Nevertheless, the inventories were evaluated to determine if they are within the bounds of the PA. This was done by comparing the canister inventories to the total PA base case inventories of all waste forms from all generators.

Table 3 shows that 8 of the 11 radionuclide/waste form combinations were reported in other waste streams (Column 5, non-zero values). Column 6 shows the canister inventories of the unanalyzed radionuclides are very small fractions of the total PA base-case inventory for these radionuclides (Column 2 ÷ Column 5). This is evidence that these unanalyzed radionuclides in canister ECF-05-18-109 will not impact the conclusions of the PA.

[3] Although the H-3 inventory is less than 1% of the total canister inventory, H-3 is a key radionuclide and any inventory greater than 1 pCi is reportable. However, because H-3 is a key radionuclide, the impact is included in RHINO calculations (see PA Check 10). Therefore, H-3 does not need to be evaluated here.

Table 3. Unanalyzed radionuclides in waste canister ECF-05-18-109 with half-lives greater than one year.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Radionuclide Inventory as % of Total Canister Inventory[b]	Total PA Base Case Inventory All Waste Forms (Ci)	Proposed Canister Radionuclide Inventory as % of Total PA Base Case Inventory All Waste Forms (Col 2/Col 5)	Phase Screened in the PA for the Groundwater Pathway
Al-26	4.58E-10	A	2.66E-10	N/A	N/A	N/A
Cd-113	1.07E-21	A	6.22E-22	N/A	N/A	N/A
Eu-152	1.04E-06	S	6.06E-07	4.14E+00	0.00003%	III
Eu-154	1.24E-06	S	7.22E-07	1.56E+01	0.00001%	III
H-3	1.37E-06	S	7.95E-07	1.99E+03	0.0000001%	Retained
Ra-228	1.41E-13	S	8.17E-14	2.28E-07	0.00006%	II
Re-186m	6.14E-08	A	3.57E-08	N/A	N/A	N/A
Sm-147	1.39E-15	S	8.07E-16	1.38E-10	0.001%	II
Th-228	4.44E-09	S	2.58E-09	2.02E-04	0.002%	III
Th-229	5.25E-13	S	3.05E-13	5.35E-08	0.001%	II
Th-230	5.73E-14	S	3.33E-14	4.93E-08	0.0001%	II

a. A = activated metal, S = surface contamination
b. Based on a total canister inventory of 172 Ci (from RHINO).
N/A = Not Applicable. Not included in any base case PA waste streams.

Three of the 11 unanalyzed radionuclide/waste form combinations were not reported in any other PA waste streams and were evaluated further. All have half-lives greater than 1 year so they would not be screened by the PA Phase I screening. Thus these radionuclides were subjected to the PA Phase II screening. The results of this screening indicate that these radionuclides would in fact have been screened out by the PA Phase II screening and are within the bounds of the PA (see Table 4). The maximum PA Phase II screening inventory in Table 4 (Column 6) is calculated using Equation 1. All of the remaining values in Column 7 are very small indicating these radionuclides would have been screened from the PA. As these and other unanalyzed radionuclides appear in future waste canisters, the same calculation will continue to be performed.

Table 4. Comparison of unanalyzed radionuclide inventories to maximum allowable Phase II screening inventories for radionuclides not reported in any other waste streams.

1	2	3	4	5	6	7
Radionuclide	Proposed Canister Inventory (Ci)	Total Facility Inventory of Previously Placed Canisters (Ci)	Sum of Proposed and Previously Placed Canisters Inventory (Ci)	NCRP Screening Dose Factor (mrem/Ci)[a]	Maximum Allowable Phase II Screening Inventory (Ci)	Sum of Proposed and Previously Placed Canisters Inventory as % of Max Allowable Phase II Screening Inventory
Al-26	4.58E-10	2.01E-07	2.01E-07	1.11E+05	3.60E-06	5.6%
Cd-113	1.07E-21	1.97E-21	3.04E-21	2.06E+05	1.94E-06	0.0000000000002%
Re-186m	6.14E-08	2.53E-07	3.15E-07	1.37E+04	2.92E-05	1.1%

a. NCRP (1996).

Non-system Radionuclides

Figure 1 shows waste canister ECF-05-18-109 contains one non-system radionuclide (Nd-144). Non-system radionuclides are not included in the RHINO database typically because they have very short or very long half-lives. Table 5 shows radionuclide Nd-144 is listed as both surface contamination and activated metal in canister ECF-05-18-109. The long half-life coupled with the very small inventory (< 1E-20 Ci) indicate Nd-144 will not have an impact on the PA.

Table 5. Non-system radionuclides in waste canister ECF-05-18-109.

Radionuclide	Proposed Canister Inventory (Ci)	Waste Form[a]	Half-Life (years)
Nd-144	1.71E-24	S	2.29E+15
Nd-144	1.14E-21	A	2.29E+15

a. A = activated metal, S = surface contamination

Summary

The radionuclide inventory of waste canister ECF-05-18-109 has been evaluated with respect to potential impacts on the PA. Based on the evaluation, impacts to the PA are small and within the bounds of the PA. Therefore, the proposed canister is deemed acceptable for disposal.

References

DOE-ID, 2018, "Performance Assessment for the INL Remote-Handled Low-Level Waste Disposal Facility," DOE/ID-11421, Revision 2, U.S. Department of Energy, Idaho Operations Office, February 2018.

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RH-ADM-5214, 2024, "DOE Order 435.1 Documentation Change Control Process for the Remote-Handled Low-Level Waste Disposal Facility," RH-ADM-5214, Revision 1, Idaho National Laboratory.

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Jonathan Jacobson	Jonathan Jacobson Jonathan Jacobson (Sep 18, 2024 13:27 MDT)	Sep 18, 2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
James Angell Neal E Russell	James Angell Neal Russell James Angell (Sep 19, 2024 11:18 MDT) Neal Russell (Sep 18, 2024 14:29 MDT)	Sep 19, 2024 Sep 18, 2024
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	09/18/2024
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul Velasquez	Paul Velasquez	Sep 18, 2024
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault Timothy Arsenault (Sep 18, 2024 12:34 MDT)	Sep 18, 2024
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________________

Special Analysis Document Number: ______________________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________________

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Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

UNREVIEWED DISPOSAL QUESTION SCREENING (UDQS) AND EVALUATION (UDQE) FORM FOR THE RHLLW DISPOSAL FACILITY

UDQE Tracking No.: UDQE-RHLLW-105

Subject: 2024 Annual HFEF CVAS Inspection with Level 3 or Greater Damage Identified

NOTE: *The objective of this screening is to determine whether further evaluation is required for a proposed change, new information, or discovery to ensure the validity of the existing Performance Assessment (PA; DOE/ID-11421) and Composite Analysis (CA; DOE/ID-11422) are not impacted.*

Describe the Proposed Change in Activity/New Information/Discovery:

As required by PLN-3368: "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," the 2024 annual B21-632 HFEF Cask-to-Vault Adapting Structure (CVAS) inspection was performed. The "System Design Description-Remote-Handled Low-Level Waste Disposal Vault System (SDD-410)" requires inspection (and subsequent repair, if necessary) of concrete damage to be performed using criteria carried forward from facility design to operations. The criteria used during vault fabrication are documented in SPC-1857 and during vault installation in SPC-1910. Inspection criteria employed during vault fabrication included identification of concrete defects introduced during the vault fabrication process (i.e., bug holes, honeycombing, air bubble marks, cracking and seals offset) in addition to Level 1, Level 2, and Level 3 damage (e.g., crack, chipping, spalling) to components occurring after the vault components were fabricated. During vault installation, the inspection criteria were reduced to include only the Level 1, Level 2, and Level 3 post-fabrication cracking and spalling damage (see SPC-1910) using the performance measures provided in SPC-1857. SDD-410 and RH-ADM-5214: "DOE Order 435.1 Documentation Change Control Process for the RH-LLW Disposal Facility," require inspection and repair of any new Level 3 post-fabrication cracking and spalling damage using the criteria and procedures specified in SPC-1910 and carried forward into SDD-410. Level 3 damage is of importance since it has the potential to impact the functional performance of the vault shield plugs and CVAS.

This UDQE is being prepared and evaluated because the annual inspection work order (WO) 358738 identified new Level 3 defects on the HFEF CVAS as follows:

- The HFEF CVAS exhibited two cracks that are >0.010-in wide, and approximately 2 1/2-in in length.
- One chip defect was identified approximately 8-3/4" L x 1-3/4" W x 1-1/2" D near the access port.

These defects are being evaluated in this UDQE to ensure the CVAS is acceptable for use and defects are repaired and inspected per the requirements of SDD-410 using the procedures approved in SPC-1910 and implemented in Model Work Order (MWO) 258120.

Section I, Unreviewed Disposal Question Screening (UDQS)

1. *Does the proposed activity/new information/discovery involve a change to the disposal facility from what has been previously or analyzed in the most recent Disposal Authorization Statement (DAS) conditions or limitations, Performance Assessment (PA), approved Special Analyses (SA), or approved UDQE?*

Yes ☒ No ☐

Comments:

Level 3 damage has the potential to impact the long-term performance of the HFEF CVAS. The concrete vaults provide structural protection to the stainless-steel canisters and provide structural support of the final engineered cover. The CVAS is used in place of a vault shield plug during waste emplacement activities and may be in place for an extended but non-permanent length of time and; therefore, is treated the same as a vault shield plug. Damage to the CVAS could also potentially damage the top mating surface of the vault upper riser during use.

2. *Does the proposed activity/new information/discovery potentially result in an increased effective dose from the disposal facility that would challenge the conclusions of the Composite Analysis (i.e., that the RHLLW Disposal Facility has **de minimus** contribution to the cumulative impacts of surrounding facilities) or otherwise have the potential to impact the CA?*
   - *Change to the site use plan or end state document*
   - *Construction of a new facility near the RHLLW Disposal Facility with the potential to impact perched water*
   - *CA inputs or assumptions*
   - *Change to work outlined in the PA/CA Maintenance Plan (PLN-3368).*

Yes ☐ No ☒

Comments: NA

3. *Does the proposed activity/new information/discovery involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

4. *Does the proposed activity/new information/discovery involve a change to the Waste Acceptance Criteria (WAC) from what has been previously described or analyzed in the most recent PA, approved SA, or approved UDQE?*

Yes ☐ No ☒

Comments: NA

5. *Does the proposed activity/new information/discovery involve a change inputs or assumptions of the most recent PA or approved SA?*

Yes ☐ No ☒

Comments: NA

6. *Does the proposed activity/new information/discovery result in a change the facility preliminary closure approach or criteria from what was previously described or analyzed in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

7. *Does the proposed activity/new information/discovery involve a test or experiment not described or analyzed in*

the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?

Yes ☐ No ☒

Comments: NA

8. *Does the proposed activity/new information/discovery involve any analytical errors, omissions, or deficiencies in the most recent PA, approved SA, approved UDQE, or associated closure plan (PLN-5503)?*

Yes ☐ No ☒

Comments: NA

9. *Do other considerations warrant development of an evaluation or special analysis?*

Yes ☐ No ☒

Comments: NA

NOTE: *If all questions above are answered "No," then obtain signatures and implement proposed change. If any of the questions above are answered "Yes," then continue with Form and complete Unreviewed Disposal Questions Evaluation Section.*

Explanation/Additional Comments:

Does the Unreviewed Disposal Question Screening screen negative or positive?

Negative ☐ Positive ☒

Is an Unreviewed Disposal Question Evaluation or Special Analysis needed?

No ☐ UDQE ☒ Special Analysis ☐

Jonathan Jacobson	Jonathan Jacobson (Sep 26, 2024 11:19 MDT)	Sep 26, 2024
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault Timothy Arsenault (Sep 26, 2024 11:30 MDT)	Sep 26, 2024
Print/Type Name Approver/NFM	Signature Approver/NFM	Date

Section II, Unreviewed Disposal Question Evaluation (UDQE)

Evaluation:

1. *Is the proposed activity/new information/discovery outside the bounds of the approved PA or CA (e.g., does the proposed activity/new information/discovery involve a change to the basic disposal concept as described in the PA/CA such as critical inputs/assumptions or an increase in facility inventory analyzed in the PA or considered in the CA)?*

Yes ☐ No ☒

Comments:

2. *Does the proposed activity/new information/discovery result in the PA performance objective being exceeded?*

Yes ☐ No ☒

Comments:

3. *Would the proposed activity/new information/discovery result in a change to the facility radionuclide disposal limits in the approved PA?*

Yes ☐ No ☒

Comments:

4. *Would the proposed activity/new information/discovery result in a change to DAS conditions or limitations?*

Yes ☐ No ☒

Comments:

5. *Does the proposed activity/new information/discovery have the potential to result in a significant change impacting the ability of the disposal facility to meet the performance objectives of DOE Order 435.1 or alter conditions of the DAS and require a special analysis?*

Yes ☐ No ☒

If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

If "No," provide an explanation and basis for the determination. Attach supplementary documentation (e.g., TEV), as required.

Explanation:

SPC-1857 identifies Level 1, Level 2 and Level 3 damage and defect types. Level 1 and Level 2 damage and defects have been determined to pose an insignificant impact to long-term vault performance (i.e., shielding, weight bearing, and long-term vault performance) if left unrepaired. Level 3 damage (i.e., new cracks, chipping and spalling) has been determined to pose a potential performance risk.

The annual inspection WO 358738 (MWO 257899) requires the HFEF and MFTC CVASs to be visually inspected for cracks, chipping, and spalling of concrete per the preventative maintenance program. As required by the annual WO, the inspection was performed and identified Level 3 damaged areas on the HFEF CVAS as noted in the description section of this UDQE.

Evaluation of Damage:

Damages on the HFEF CVAS: The damage appears to be similar to the cracks evaluated in document: "Assessment of the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility Vault Concrete Data (INL/EXT-17-42239)." As evaluated in INL/EXT-17-42239, given the damage origin and dimensions and the fact that it is on a CVAS (a non-permanent vault component), the damages would not be expected to impact long-term vault performance. The chip areas exposed no rebar and are not of significant depth to result in structural concerns per engineering judgement. The chip dimensions are typical of previously-identified chips on the CVAS and other vault shield plugs, which have been successfully repaired. However, as required by SDD-410, the damages will be repaired using approved repair materials (see SPC-1910; Jet Set Smooth for cracks and Jet Set Complete for chips) and re-inspected. As with defects repaired during vault fabrication, these repairs are expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance. Additionally, Labway Operability Review OPR 2024-0134 was completed to determine if the damage could impact the CVAS safety/functional performance per SAR-419. The completed and approved review resulted in the determination that the CVAS is still functional with no impact to its safety function and is unlikely to impact the operability of the vault shield plugs.

For all repairs, the requirements of SDD-410 and shown in SPC-1910, Section 2.2 and 2.3 were followed as implemented in the model work order. The repairs were made using model routine repair WO 258120 and MWR 2024-2659 and performed by trained personnel. Repairs were successfully completed using WO 364224, which is a copy of the MWO with a unique WO number specific to this iteration; post-maintenance inspections showed no issues.

Print/Type Name	Signature	Date
Jonathan Jacobson Originator/FDS	Jonathan Jacobson (Sep 26, 2024 11:19 MDT) Originator/FDS	Sep 26, 2024
James Angell Neal E Russell System Engineer/SE	James Angell; Neal Russell (Sep 30, 2024 07:08 MDT) System Engineer/SE	Sep 28, 2024 Sep 30, 2024
A. Jeff Sondrup PA/CA SME	Jeff Sondrup (Sep 26, 2024 13:09 MDT) PA/CA SME	Sep 26, 2024
Paul Velasquez Waste Management/WMP	Paul Velasquez Waste Management/WMP	Sep 27, 2024
Tim Arsenault Nuclear Facility Manger/NFM	Timothy Arsenault (Sep 26, 2024 11:30 MDT) Nuclear Facility Manger/NFM	Sep 26, 2024

Section III, Special Analysis, SA (If Required in Section I or II)

PARC Assigned SME: ______________________

Special Analysis Document Number: ______________________

Proposed Activity Approved? Yes ☐ No ☐

Comments: ______________________

____

____

Print/Type Name	Signature	Date
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Print/Type Name Nuclear Facility Manger/NFM	Signature Nuclear Facility Manger/NFM	Date
Print/Type Name DOE/ID Representative	Signature DOE/ID Representative	Date

Appendix B

Compliance and Performance-Monitoring Data for the RHLLW Disposal Facility

Aquifer and lysimeter sampling are conducted according to the facility monitoring plan (PLN-5501) and the following laboratory instructions:

- LI-849, "Groundwater Monitoring at the Remote-Handled Low-Level Waste Disposal Facility."
- LI-859, "Sampling Vadose Zone Water at the Remote-Handled Low-Level Waste Disposal Facility."

FY 2024 aquifer and lysimeter-sample analysis was performed by GEL Laboratories LLC, in Charleston, South Carolina. Data were validated to Radioanalytical Validation Level B by Analytical Quality Associates, Inc., in Albuquerque, New Mexico. Aquifer sample and validation results are documented in the following reports:

- Lab Data Report for Sample Data Group: BEA01-5451-01, Work Order 665338.
- Limitations and Validation Report: AR0003_ BEA01-5451-01_LVR for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2024.
- Lab Data Report for Sample Data Group: BEA01-5444-01, Work Order 665493.
- Limitations and Validation Report: AR0002_BEA01-5444-01_LVR for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2024.

Lysimeter-sample results are documented in the following reports:

- Lab Data Report for Sample Data Group: BEA01-5500-02, Work Order 663382.
- Limitations and Validation Report: AR0001_ BEA01-5500-02_LVR_REV01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, July 2024.

All aquifer and lysimeter results are uploaded and maintained in the INL Environmental Data Warehouse. The following tables and figures are shown below:

- Table B-1. Aquifer sampling results for RHLLW Disposal Facility compliance monitoring wells for FY 2024.
- Table B-2. Average groundwater concentrations in RHLLW Disposal Facility compliance monitoring wells for FY 2024.
- Table B-3. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FY 2019–2024).
- Table B-4. Summary of RHLLW Disposal Facility lysimeter sampling results for FY 2024.
- Figure B-1. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FYs 2019–2024).

Table B-1. Aquifer sampling results for RHLLW Disposal Facility compliance monitoring wells for FY 2024.

Constituent	Result Type	Date Collected	Concentration (pCi/L)	Uncertainty	Validation Qualifier
Well USGS-136					
Gross alpha	Original	4/24/2024	1.62	0.395	
Gross beta	Original	4/24/2024	4.38	0.327	
C-14	Original	4/24/2024	-2.06	12.2	U
H-3	Original	4/24/2024	284	92.5	
I-129	Original	4/24/2024	-0.015	0.088	U
Tc-99	Original	4/24/2024	-33.5	12	U
Well USGS-140					
Gross alpha	Original	4/29/2024	1.06	0.383	UJ
Gross beta	Original	4/29/2024	2.34	0.278	
C-14	Original	4/29/2024	4.47	11.9	U
H-3	Original	4/29/2024	358	123	UJ
I-129	Original	4/29/2024	0.0803	0.0998	U
Tc-99	Original	4/29/2024	4.83	10	U
Gross alpha	Duplicate	4/29/2024	1.94	0.455	
Gross beta	Duplicate	4/29/2024	2.73	0.289	
C-14	Duplicate	4/29/2024	1.19	11.8	U
H-3	Duplicate	4/29/2024	588	141	
I-129	Duplicate	4/29/2024	0.0635	0.237	U
Tc-99	Duplicate	4/29/2024	-7.03	9.88	U
Well USGS-141					
Gross alpha	Original	4/30/2024	1.95	0.512	
Gross beta	Original	4/30/2024	2.96	0.426	
C-14	Original	4/30/2024	-11.6	12	U
H-3	Original	4/30/2024	634	129	
I-129	Original	4/30/2024	0.015	0.211	U
Tc-99	Original	4/30/2024	-13.3	12.5	U

U = Analyte was analyzed for but not detected above the minimum detectable activity. Results should not be used.

UJ = Analyte may or may not be present, and the result is considered highly questionable. Results should not be used.

Results with no U or UJ flag were statistically positive at the 95% confidence interval and above the minimum detectable concentration. This generally corresponds to the result being greater than three times the measurement uncertainty.

Table B-2. Average groundwater concentrations in RHLLW Disposal Facility compliance monitoring wells for FY 2024.

Well	Average Sample Result (pCi/L)[a]					
	Gross alpha	Gross beta	C-14	H-3	I-129	Tc-99
USGS-136	1.62	4.38	U	284	U	U
USGS-140	1.94	2.54	U	588	U	U
USGS-141	1.95	2.96	U	634	U	U
Action Level[b]	15	50	2,000	20,000	1	900
Regional Background Range[c]	ND - 26.4	0.4 - 43.5	ND - 64.3	ND - 18,800	ND - 0.48	ND - 4.8

U = Analyte was analyzed for but not detected above the minimum detectable activity.

UJ = Analyte may or may not be present, and the result is considered highly questionable.

Results with no U or UJ flag were statistically positive at the 95% confidence interval and above the minimum detectable concentration. This generally corresponds to the result being greater than three times the measurement uncertainty (see Table B-1).

ND = Non-detect

a. Average values do not include U- or UJ-qualified data. Average values include duplicate sample data if the analyte was detected in both the original and duplicate samples.

b. Action levels are MCLs except for gross beta. The MCL for gross alpha does not include radon or uranium. There is no MCL for gross beta, and it is not listed in the monitoring plan (PLN-5501) as an action level. 50 pCi/L is a screening level for sensitive drinking water systems based on EPA Radionuclides Rule 66 FR 76708 (EPA 2000). Other MCLs are based on a 4 mrem/year critical organ dose for beta/photon emitters.

c. *Assessment of Aquifer Baseline Conditions at the INL RHLLW Disposal Facility* (INL 2017).

Table B-3. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FYs 2019–2024). Data is shown graphically in Table B-1.

Well	Date	Average Tritium Concentration[a] (pCi/L)
USGS-136	10/1/2018	1,380
	4/30/2019	1,485
	4/27/2020	932
	4/15/2021	916
	4/18/2022	1,110
	9/16/2022	535
	5/15/2023	649
	9/18/2023	748
	4/24/2024	284
USGS-140	10/1/2018	1,490
	4/30/2019	1,060
	4/28/2020	964
	4/19/2021	739
	4/19/2022	992
	9/21/2022	842
	5/16/2023	835
	9/25/2023	485
	4/29/2024	588

Well	Date	Average Tritium Concentration[a] (pCi/L)
USGS-141	10/1/2018	1,140
	4/30/2019	1,520
	4/28/2020	815
	4/19/2021	608
	4/19/2022	825
	9/21/2022	874
	5/16/2023	683
	9/25/2023	561
	4/30/2024	634

a. Average values include duplicate sample data only if the analyte was detected in both the original and duplicate samples.

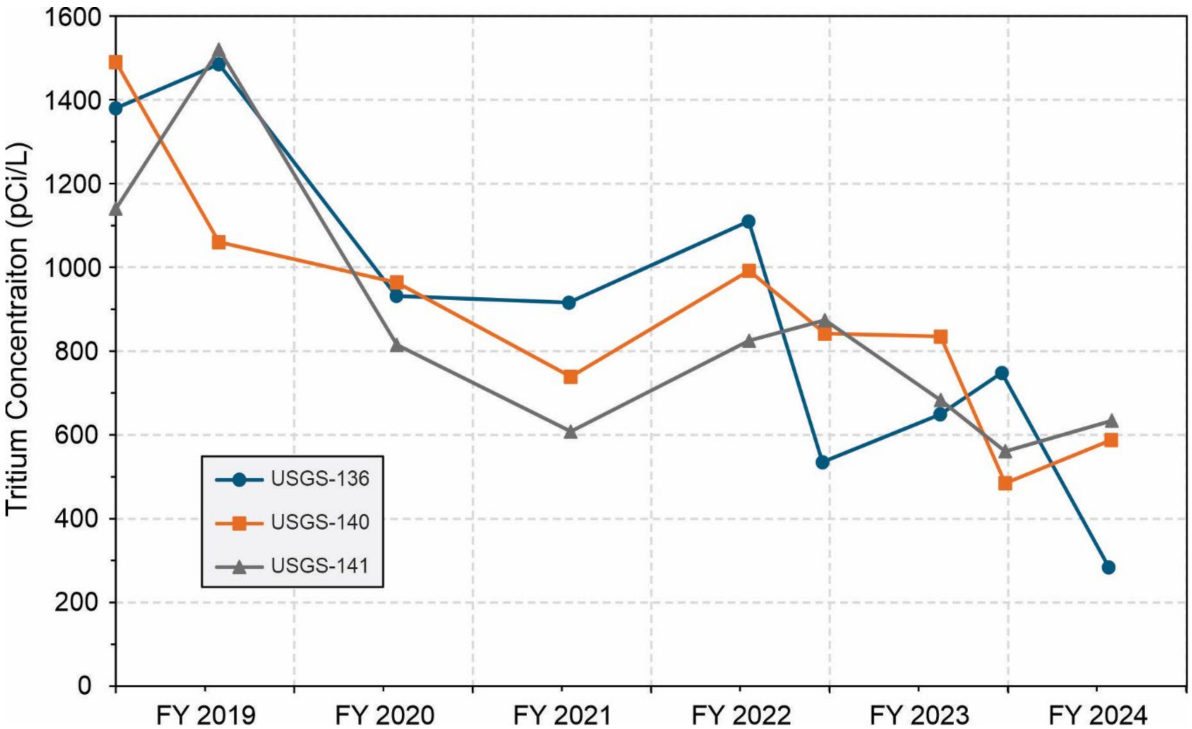

Figure B-1. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance-monitoring wells (FYs 2019–2024).

Table B-4. Summary of RHLLW Disposal Facility lysimeter sampling results for FY 2024.

Lysimeter	Total Sample Volume (mL)	Sample Result (pCi/L)		
		Gross alpha	Gross beta	H-3
Shallow-Alluvium Lysimeters (26–29 ft below land surface)				
PA-North[a]				
PA-South[a]				
NuPac-West	561[c]	1.97 (1.48)	1.64 (0.786 UJ)	78.7 U
NuPac-East[a]				
55-ton-South	531[c]	3.20	2.63	136 U (223 UJ)
HFEF-South	318[b]	1.60	1.47	4,100
LCC-West[a]				
LCC-East	544[c]	0.756 UJ (0.969)	2.43 (1.47)	33.4 U
MFTC-West	505[c]	1.40	1.80	123 U (131 U)
MFTC-East[a]				
Deep-Alluvium Lysimeters (40–44 ft below land surface)				
HFEF-South-45[a]				
LCC-West-45[a]				
LCC-East-45[a]				
NuPac-West-45[a]				
NuPac-East-45[a]				
55-ton-South-45[a]				
MFTC-West-45[a]				
MFTC-East-45[a]				
Sedimentary-Interbed Lysimeters (170–176 ft below land surface)				
NuPac-SIW[a]				
MFTC-West-SIW[a]				
MFTC-East-SIW	548[c]	2.22 (2.72)	2.37 (2.55)	-33.1 U
Action Level[d] or MCL[e]		10[d]	40[d]	20,000[e]

a. Lysimeter removed from regular scheduled collection during the post-baseline monitoring phase due to difficulty obtaining water. Attempts to collect samples will only be performed if deemed necessary by the PA review committee (see PLN-5501, Revision 3).

b. Sample volume sufficient for full suite of analytes.

c. Sample volume sufficient for full suite of analytes and duplicates (Dup) of some analytes. Duplicate results are shown in parentheses.

d. Action levels (PLN-5501) are only defined for gross alpha and gross beta.

e. Federal drinking water MCLs are not action levels and do not apply to lysimeter samples. They are provided for comparison and informational purposes only.

--- Indicates sample volume was insufficient for analysis.

U = Radionuclide is not considered to be present in the sample. Sample result is not included.

UJ = Radionuclide may or may not be present in the sample, and the sample result (not included) is considered highly questionable.

J = Radionuclide is considered present in the sample, but the sample result is questionable.

Results with no U or UJ flag were statistically positive at the 95% confidence interval and above the minimum detectable concentration. This generally corresponds to the result being greater than 3 times the measurement uncertainty.

BOLD font indicates result above action level (see footnote d).