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Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2022

March 2023

A. Jeffrey Sondrup, Jonathan Jacobson, Allen Prather, and Tim Arsenault
Idaho National Laboratory

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EXECUTIVE SUMMARY

This Fiscal Year (FY) 2022 annual summary report (ASR) documents the continued adequacy of the performance assessment (PA), the composite analysis (CA)[a] and associated operating disposal-authorization statement (ODAS) technical-basis documents for the Remote-Handled (RH) Low-Level Waste (LLW) Disposal Facility at Idaho National Laboratory. Annual review of the adequacy of the PA and CA for the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility ensures that conclusions of the analyses remain valid in accordance with requirements of Department of Energy (DOE) Order 435.1, "Radioactive Waste Management."

In FY 2022, 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. Fifteen waste canister shipments were received at the RHLLW Disposal Facility, and 15 waste canisters were emplaced in disposal vaults.

Except for an update to the change control process document (RH-ADM-5214, formerly SD-52.1.4), there were no updates to the PA, CA, ODAS, radioactive-waste-management basis (RWMB) or other technical-basis documents in FY 2022. The update of RH-ADM-5214 is discussed in Section 2.9.2 (see also Table 2, unreviewed disposal question evaluation [UDQE]-RHLLW-054). The current revisions of the documents as of FY 2022 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
- "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," PLN-3368, Revision 3
- "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," PLN-5501, Revision 2
- "Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," PLN-3370, Revision 0
- "Addendum to the Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," PLN-5503, Revision 0

[a] 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.

- "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," PLN-5446, Revision 1
- "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," RH-ADM-5214, Revision 0.

Ongoing Activities

In FY 2022, routine PA and CA maintenance activities remained unchanged in accordance with PLN-3368, the PA/CA maintenance plan, and PLN-5501, the facility-monitoring plan. No new activities or information were identified in FY 2022 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, or new information that could potentially impact the conclusions or assumptions of the PA, CA, ODAS, or radioactive-waste-management basis (RWMB) were identified and evaluated through the unreviewed disposal question screening/unreviewed disposal question evaluation (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." Work was performed on 20 UDQS/UDQEs in FY 2022. No special analyses were required or performed, and no impacts to the PA, CA, ODAS, or RWMB were identified as a result of the evaluations that were completed and approved in FY 2022. However, UDQE-RHLLW-063 (see Table 2), which was in progress at the end of FY 2022 will determine if a special analysis is required to address a request by Naval Reactors Facility (NRF) Waste Programs for a permanent exception to limits of removable surface contamination on the exterior of waste canisters. Work that would form the basis for the special analyses was initiated in FY 2022 (see Section 2.7). A determination on UDQE-RHLLW-063 and the special analysis (if necessary) is expected in FY 2023.

Waste Receipts

The only waste streams approved for shipment to the RHLLW Disposal Facility in FY 2022 were activated metals and surface-contaminated debris in Hot Fuel Examination Facility (HFEF)-5 canisters from the Materials and Fuels Complex (MFC). Fifteen HFEF-5 waste canisters were shipped to the facility and disposed of in the HFEF-vault array in FY 2022. This brings the total number of HFEF-5 waste canister disposals to 60 by the end of FY 2022, and leaves space for 120 additional canisters of this type. No other vault arrays received waste, and the facility is at 6.4% of capacity based on canisters.

[b] 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."

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)[b] (TFR-981 2018). In the 15 waste canisters placed in FY 2022, 19 radionuclides were reported in activated metals and 122 radionuclides were reported as surface contamination. Nine radionuclides were reported as both activated metal and surface contamination. Nine of the reported radionuclides are considered "non-system" radionuclides, meaning they were not considered in the PA and are not included in the RHINO database. Non-system radionuclides were evaluated using the UDQE process (see Section 2.1).

Of the 14 radionuclides fully analyzed in the PA for the groundwater (all-pathway) dose, only Cl-36 was not reported in any of the 15 waste canisters. All five radionuclides that contribute to the PA intruder-pathway dose were reported. All three radionuclides that contribute to the PA air-pathway dose (C-14, H-3, and I-129) were reported. Of the 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), only Cl-36 was not reported.

The cumulative inventory of radionuclides disposed of is approximately as expected or less than expected for seven of the 14 groundwater-pathway radionuclides for each waste stream based on projections used in the PA. Large percentages of Np-237, Pu-240, U-238, U-235, and Pu-239 are due primarily to larger than expected inventories in the new-generation (non-legacy) waste canister MFC210277 from the Fuel Conditioning Facility (FCF) at MFC. This canister was flagged by RHINO for exceeding the 10% PA inventory threshold of several radionuclides for the specific generator/canister/waste form and evaluated for disposal acceptance in UDQE-RHLLW-053. The large percentages of H-3 and I-129 are from larger than expected inventories in canisters SN-148 and MFC110124 respectively. Because of these discrepancies, the inventory projections of legacy and new-generation waste from MFC are being evaluated.

Facility performance was calculated and tracked using RHINO. The calculated maximum dose and concentration performance measures from the 15 waste canisters disposed of in FY 2022 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.

[b] 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."

Facility and Environmental Monitoring

Facility monitoring consists of annual inspections of the vault-yard road apron and 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 2022 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. The vault inspection revealed damage to four vault shield plugs. The damage is relatively minor, and repairs will be completed in FY 2023. Moderate vegetation (weed) growth was observed in a few areas of the vault-yard perimeter, and the vegetation was sprayed and/or removed. One indication of animal nesting or burrowing was observed and corrected. No other evidence of burrowing insects or animals was identified.

Environmental monitoring was conducted in FY 2022 in accordance with PLN-5501, "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." Compliance monitoring consists of annual sampling of three aquifer wells (one upgradient, two downgradient) near the facility. Samples are collected annually from each well and analyzed to confirm compliance with state groundwater-quality standards (IDAPA 58.01.11). Semi-annual groundwater sampling was also performed in FY 2022 due to some lysimeter samples exceeding the gross-alpha action level.

Groundwater samples were analyzed for indicator analytes gross alpha and gross beta, and for target analytes C-14, H-3, I-129, and Tc-99. H-3 and gross beta were 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).

Performance monitoring was conducted by collecting and analyzing soil-porewater samples, where sufficient water was present, from vadose zone lysimeters installed in native materials adjacent to, but below the base of the vault arrays. Samples were analyzed for the same target and indicator analytes as the aquifer samples (gross alpha, gross beta, H-3, C-14, I-129, and Tc-99) according to sample availability. A preliminary evaluation of lysimeter data collected during the 3-year period to establish baseline concentrations (FY 2019 through FY 2021) was performed in FY 2022 prior to collection of samples in the spring. This evaluation determined that insufficient data had been collected to determine baseline concentrations for several lysimeters and analytes (see Appendix B, Table B-6). As a result, the baseline period was extended and routine sampling was performed in FY 2022. However, analyte priorities were modified for specific lysimeters so that samples would be analyzed for analytes with fewer data.

In general, FY 2022 sample collection from shallow-alluvium lysimeters continued to be reasonably good, sample collection from deep-alluvium lysimeters continued to be poor, and sample collection from the shallow interbed lysimeters improved.

In addition to routine lysimeter sampling in the spring, six lysimeters were sampled in the fall of 2021 (FY 2022) and analyzed for tritium and other analytes as sample volumes permitted. This "non-routine" sampling effort was conducted in response to an unexpectedly high tritium result from lysimeter HFEF-South in spring FY 2020. Although there is no action level for tritium in soil porewater, semi-annual sampling of these six lysimeters for tritium analysis will continue until the tritium concentration in lysimeter HFEF-South declines to less than the federal drinking water maximum contaminant level (MCL) of 20,000 pCi/L. The latest sample result from spring 2022, 27,000 pCi/L, is down from a high of 47,100 pCi/L in spring 2020.

All performance-monitoring sample results were less than action levels with two exceptions. The porewater sample from shallow-alluvium lysimeter PA-North and a combined sample from six deep-alluvium lysimeters exceeded the gross-alpha action level of 10 pCi/L. These results are consistent with results from previous years.

Design, Operations, and Closure Conditions

During FY 2022, there were no changes in the design, construction, or operation of the RHLLW Disposal Facility.

PLN-3370, the preliminary closure plan, and PLN-5503, the preliminary closure plan addendum, 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 completed in FY 2022 required a special analysis; therefore, no special analyses were required or prepared. However, UDQE-RHLLW-063 (see Table 2), which was in progress at the end of FY 2022 will determine if a special analysis is required to address a request by Naval Reactors Facility (NRF) Waste Programs for a permanent exception to limits of removable surface contamination on the exterior of waste canisters. Work that would form the basis for the special analyses was initiated in FY 2022 (see Section 2.7). A determination on UDQE-RHLLW-063 and the special analysis (if necessary) is expected in FY 2023. If the special analysis is approved, a WAC revision will be required.

Research and Development Activities

No research and development activities were conducted at the RHLLW Disposal Facility in FY 2022.

Planned or Contemplated Changes

Planned or contemplated changes for FY 2023 include a revision of the PLN-5446, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," the PLN-5501, "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low Level Waste Disposal Facility," and the FRM-2544, "Remote-Handled Low-Level Waste Canister Acceptance Sheet." Waste generator certification of NRF should be finalized in FY 2023, and certification of the Advanced Test Reactor (ATR) Complex will begin. Operational activities associated with shipment and disposal of 55-ton waste canisters from NRF are expected to begin in FY 2023. Monitoring data from all lysimeters collected during the 3-year baseline period (FY 2019 through FY 2021) and extended to FY 2022 will also be evaluated. This evaluation will be documented in a report with recommendations to either extend the baseline period or move to the next phase. No changes are planned or contemplated for facility design, construction, or closure.

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

ASR	Annual Summary Report
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
CA	composite analysis
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIC	Core Internals Changeout
CLUES	Comprehensive Land Use and Environmental Stewardship
CVAS	Cask-to-Vault Adapter System
DE	dose equivalent
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
ECAR	Engineering Calculations and Analysis Report
ED	effective dose
EPA	Environmental Protection Agency
FCF	Fuel Conditioning 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
LLW	low-level waste
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
RH	remote-handled
RHINO	Remote-Handled Low-Level Waste Disposal Facility Inventory Online
RWMB	radioactive-waste-management basis
SC	surface-contaminated
SCR	software-change request

SD	standing directive
UDQE	unreviewed disposal question evaluation
UDQS	unreviewed disposal question screening
VSP	vault shield plug
WAC	waste acceptance criteria
WO	work order

Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2022

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)[c] for the Remote-Handled (RH) Low-Level Waste (LLW) 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 Remote-Handled Low-Level Waste (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 FY 2022, 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 2022 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.

[c] 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.

1.1 Site and Facility Background

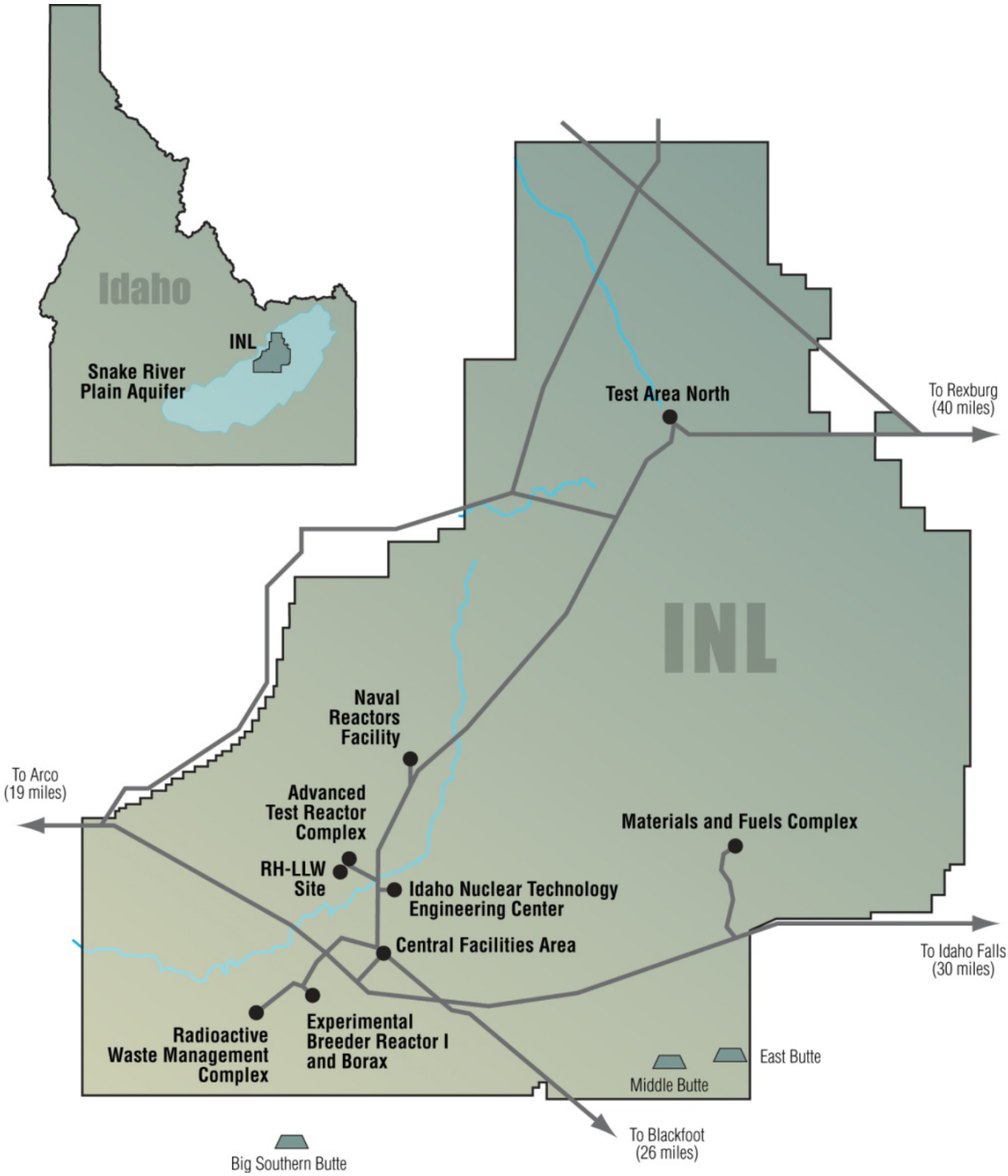

Figure 1. Map of INL Site showing the locations of major facilities including the RHLLW Disposal Facility.

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

Table 1. Waste cask/canister systems planned for disposal 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	Large Concept Cask (LCC) Cask/Canisters	Ion-Exchange Resins/Activated Metals	Array 2 (LCC Vaults)
NRF	55-ton Scrap Cask/Canisters	Ion-Exchange Resins/Activated Metals	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[d]	Activated Metals	Array 2 (HFEF Vaults)
MFC	Hot Fuel Examination Facility (HFEF)-5 Cask/Canisters	Activated Metals/Debris	Array 2 (HFEF Vaults)

[d] During facility design and construction, ATR-canal waste was described as being handled using an HFEF-5-like cask/canister system. This system has been developed and designated the ATR-5 cask/canister system.

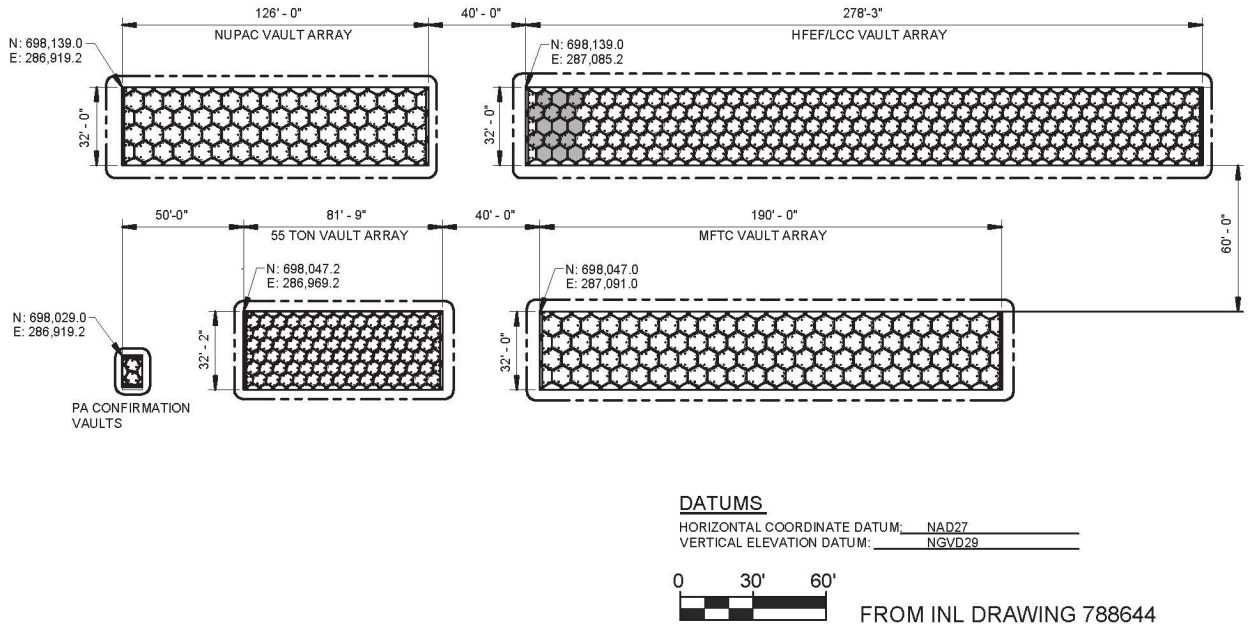

Figure 3. Horizontal layout of the disposal vault arrays at the RHLLW Disposal Facility.

1.2 Purpose and Scope

The purpose of this FY 2022 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 the report concludes FY 2022 RHLLW Disposal Facility operations were conducted within the bounds of the PA, CA, and ODAS. This ASR addresses RHLLW Disposal Facility operations for FY 2022 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 2022 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 radioactive-waste-management basis (RWMB) that occurred in FY 2022

Section 3—Discussion of the cumulative effect of changes that occurred in FY 2022

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 the 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 2022 based on summary information presented in this report.

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

Fifteen waste canister disposals were performed in FY 2022 at the RHLLW Disposal Facility. This brings the total number of canister disposals to 60 by the end of FY 2022. There were no impacts to the RHLLW Disposal Facility PA, CA, ODAS, or RWMB as a result of changes in operations or other activities in FY 2022.

Other than an update to the change control process document (RH-ADM-5214, formerly SD-52.1.4) (see Table 2, UDQE-RHLLW-054), there were no updates to the PA, CA, ODAS, RWMB, or other technical-basis documents in FY 2022. The current revisions of the documents as of FY 2022 are as follows[e]:

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

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 through 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 2022. A summary of all UDQSs and UDQEs that were in progress at the end of FY 2021 or initiated in FY 2022 is provided in Table 2. All UDQS/UDQE forms completed and approved in FY 2022 are provided in Appendix A.

Work was performed on 20 UDQS/UDQEs in FY 2022, which included four UDQS/UDQEs carried over from FY 2021. Two that were in progress at the end of FY 2021 are still on hold until additional information is obtained from the waste generator. Of the remaining 18 UDQS/UDQEs, three were

[e] 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.

screened negative and were approved, nine were screened positive requiring an evaluation, and six are still in the process of being screened. Of the nine that screened positive and required evaluations, all nine evaluations were negative, meaning the change, activity, or new information was determined to be within the bounds of the PA, CA, and ODAS.

Five of the nine UDQS/UDQEs that screened positive and required evaluation were for HFEF-5 canisters with radionuclide inventories flagged by the RHLLW Inventory Online (RHINO[f]) software. Prior to shipment, waste canisters 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 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 waste stream/canister. 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 if the inventories and dose impacts are within the bounds of the PA.

Four of the 15 canisters evaluated for disposal in FY 2022 contained radionuclides whose inventories exceeded WAC threshold values and required a full dose consequence analysis. These analyses were documented in ECAR-5771 and ECAR-6333. All 15 canisters evaluated for disposal in FY 2022 were flagged by RHINO PA checks and required evaluation. After evaluation, the waste canisters were deemed acceptable for disposal from a safety basis perspective, and inventories and dose impacts were considered acceptable and within the bounds of the PA.

Initial waste generator certification of Naval Reactors Facility (NRF) as a generator of 55-ton waste canisters containing activated metals and surface-contaminated debris began in FY 2022. RHLLW Disposal Facility personnel performed a peer review of NRF waste certification programs as a prelude to the actual certification. The review indicated that surface contamination on the 55-ton waste canisters would likely exceed acceptability limits, as defined in Section 2.6 of the RHLLW WAC (PLN-5446), without additional mitigating steps above those currently employed by NRF Waste Programs. NRF waste canisters are loaded underwater due to extremely high-radiation levels, and NRF is not able to directly measure the surface contamination on the canisters after they are loaded into the shipping cask directly above the water. The high-radiation levels prohibit safely lifting the loaded waste canister out of the water pools for contamination surveys to validate contamination levels. NRF reduces the amount of contamination on the outside of the canisters by placing radioactive water demineralizer systems in waste loading zones of the water pool, performing an underwater high-pressure wash (hydroblitz) of the canister exteriors, and performing a low-pressure rinse of the canister exterior as it is loaded into the shipping cask. NRF Waste Programs performed underwater swipes after the hydroblitz step to measure the removable surface contamination on waste canisters, and it was determined that levels would not consistently meet the limits identified in the WAC. Based on the evaluation of the underwater swipe data, NRF requested a permanent exception to the WAC Section 2.6 surface contamination levels for all waste canisters and provided proposed surface contamination limits that could be achieved. UDQE-RHLLW-063 was initiated to evaluate this request and was in progress at the end of FY 2022. A determination on the UDQE is expected in FY 2023. If it is determined that a special analysis is required, it is expected to be completed in FY 2023.

In summary, there were no special analyses performed and there were no impacts to the PA, CA, ODAS, or RWMB based on the 12 UDQS/UDQEs completed and approved in FY 2022. The need for a special analyses or a determination of impacts to the PA, CA, ODAS, or RWMB, based on the other eight

[f] 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 Handle-LLW Inventory Online Database."

UDQS/UDQEs still in progress at the end of FY 2022, is to be determined and will be reported in the FY 2023 ASR.

Table 2. Unreviewed disposal question screens and evaluations performed during FY 2022.

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 Advanced Test Reactor (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.	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.	In Progress	In Progress	In Progress	TBD	TBD
UDQE-RHLLW-049	Cask-to-vault adapter system (CVAS) exhibiting Level 3 or greater damage identified during annual inspection	The HFEF CVAS is inspected annually for damage. The 2021 inspection identified Level 3 or greater damage (crack). Damage and repairs are managed using the change-control process. The repairs were made under MWR 2021-0145 and using Work Order (WO) 2581120 by trained personnel and inspected by qualified inspector. No further action needed.	Positive	Negative	Approved	None	None
UDQE-RHLLW-050	Vault shield plugs exhibiting Level 3 or greater damage identified during annual inspection	Vault shield plugs (VSPs) are inspected annually for damage. The 2021 inspection revealed Level 3 or greater damage (chips and cracks) to three vault plugs: VSP-D2 and VSP-E1 in Vault Array 2 and the PA-South VSP. Damage and repairs are managed using the change-control process. The repairs were made under MWR 2021-4669 and using WO 258119 by trained personnel and inspected by qualified inspector. No further action needed.	Positive	Negative	Approved	None	None
UDQE-RHLLW-051	Bolt material change on Naval Spent Fuel Handling waste canister from Nitronic 60 to ASTM A453 Grade 660 Stainless Steel	NRFs canister design team has been working on design of the new Naval Spent Fuel Handling waste canister. The design team requested a change in lid bolt material from Nitronic 60 to ASTM A453 Grade 660 stainless steel. The ASTM A453 Grade 660 stainless-steel bolts were evaluated and deemed acceptable because they do not penetrate the canister outer boundary; therefore, the bolts do not violate WAC requirements or PA assumptions. No further action needed.	Negative	N/A	Approved	None	None

Table 2. (Continued.)

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-052	Disposal of surface-contaminated (SC) debris with NRF's waste streams (activated metals and resins)	As indicated in the RHLLW WAC, NRFs waste canisters may contain small amounts of SC debris. The estimated surface contaminated debris activity contribution was not included in the initial PA analysis. NRF provided activity estimates for the SC debris and found 15 radionuclides meet the minimum reporting requirements of the RHLLW WAC. An evaluation for the estimated average isotopic activity for SC was performed and determined to be within the bounds of the PA.	Positive	Negative	Approved	None	None
UDQE-RHLLW-053	Canister MFC210277 radionuclide inventory flagged by RHINO during acceptance testing	Waste canister MFC210277, a new-generation waste (non-legacy) HFEF-5 waste canister from MFC containing activated metals and surface contamination, was flagged by RHINO during PA and WAC checks, and for containing non-system radionuclides. Radionuclide inventories were evaluated and impacts were determined to be within the bounds of the PA. Dose consequences were evaluated (ECAR-5771) and determined to be within the bounds of the safety basis. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-054	Proposed changes to the RHLLW Disposal Facility change control process document SD-52.1.4	SD-52.1.4 is the RHLLW disposal facilities change control process document to ensure compliance with DOE Order 435.1 and Chapter 8 of DOE-STD-5002-2017. A decision was made to include mandatory UDQSs for all RHINO software-change requests (SCRs) and change all INL standing directives (SDs) to facility administrative procedure documents (ADMs). The change control document was revised to include both changes, and is now identified as RH-ADM-5214. Updating the change control process to included mandatory SCR screenings does not impact the PA or CA. No further action required.	Negative	N/A	Approved	None	None

Table 2. (Continued.)

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-055	Review the revised INL Site Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) 5-year review for potential impacts on the PA and CA	RHLLW Maintenance Plan (PLN-3368) requires evaluation of published INL CERCLA 5-year reviews for evaluation of potential impacts on the RHLLW PA and/or CA, including review of upgradient ground water monitoring data. The latest revision, "Five-Year Review of CERCLA Response Actions at the INL Site—Fiscal Years 2015–2019," (DOE-ID 2021a) was completed in FY 2021. The UDQE will serve as documentation that the review was conducted and summarize the findings of that review. Currently, this UDQE is in progress and expected to be completed in FY 2023.	In Progress	In Progress	In Progress	TBD	TBD
UDQE-RHLLW-056	Review Comprehensive Land Use plan or potential changes to PA and CA	The change control process document (RH-ADM-5214) requires mandatory screening for proposed changes to any DOE Order 435.1 compliance documentation or other related INL documents that have the potential to impact the assumptions and/or conclusions of the PA or CA. The latest revision of the INL Comprehensive Land Use and Environmental Stewardship (CLUES) report (INL 2020b) was reviewed and it was determined that current land use activities, and planning and decisions described in the CLUES report are consistent with assumptions in the PA and CA. No impacts to the current PA/CA are expected and no further action required.	Negative	N/A	Approved	None	None
UDQE-RHLLW-057	Review DOE-STD-1196-2022 and evaluate potential impacts to the PA and CA	Dose coefficients from DOE-STD-1196-2011 were used for PA dose calculations, which is the standard invoked by the current DOE O 458.1. The standard was revised in 2021 (DOE-STD-1196-2021) and the intent of the UDQE is to evaluate the potential impact of updated dose coefficients from the revised standard on the PA. However, the standard was revised again in 2022, so the 2022 version will now be evaluated for potential impacts. This is expected to be completed in FY 2023.	In Progress	In Progress	In Progress	TBD	TBD
UDQE-RHLLW-058	Revision to FRM-2544	Revisions to FRM-2544, "Remote-Handled Low-Level Waste Canister Acceptance Sheet," are proposed to add NRF as a certified waste generator. Depending on the outcome of UDQE-RHLLW-063, FRM-2544 may also be revised to update the limits for removable surface contamination for NRF waste canisters. Completion is expected in FY 2023.	In Progress	In Progress	In Progress	TBD	TBD

Table 2. (Continued.)

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-059	MFC legacy-waste radiological characterization methodology evolution	The waste characterization methodology for legacy-waste canisters at MFC has been changed from using the maximum recorded on-contact dose rate reading to using an average dose rate. The evaluation determined the proposed methodology provides a more representative source term for each canister, meets WAC, is within the bounds of the PA, and does not alter conditions of the ODAS. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-060	Canisters SN-104, SN-106, SN-142, OWC034 and OWC036 flagged by RHINO during acceptance testing	Five legacy HFEF-5 waste canisters (SN-104, SN-106, SN-142, OWC034, and OWC036) from MFC, were flagged by RHINO while performing PA checks. Radionuclide inventories were evaluated and impacts were determined to be within the bounds of the PA. The canisters were deemed acceptable for disposal. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-061	Canisters SN-130, SN-134, SN-148, SN-180 and MFC110124 flagged by RHINO during acceptance testing	Five legacy HFEF-5 waste canisters (SN-130, SN-134, SN-148, SN-180, and MFC110124) from MFC, were flagged by RHINO while performing PA checks. One of the canisters was also flagged because it contained a non-system radionuclide. Radionuclide inventories were evaluated and impacts were determined to be within the bounds of the PA. The canisters were deemed acceptable for disposal. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-062	Canisters SN81, SN-107 and SN-139 flagged by RHINO during acceptance testing	Three legacy HFEF-5 waste canisters (SN81, SN-107 and SN-139) from MFC, were flagged by RHINO while performing PA and WAC checks. Radionuclide inventories were evaluated and impacts were determined to be within the bounds of the PA. Dose consequences were evaluated for canisters SN81 and SN-139 (ECAR-6333) and determined to be within the bounds of the safety basis. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-063	NRF request for exception to the RHLLW WAC Section 2.6 surface contamination requirement	NRF Waste Programs requested a permanent exception to the limits of removable surface contamination on the exterior of waste canisters shipped from NRF to the RHLLW Disposal Facility as specified in the WAC, Section 2.6 (PLN-5446). NRF Waste Programs has proposed revised surface contamination limits that can be achieved at a 97.5% confidence level. The potential increase will be evaluated to determine if the limits are within the bounds of the current PA.	In Progress	In Progress	In Progress	TBD	TBD

Table 2. (Continued.)

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-064	Canister SN-128 flagged by RHINO during acceptance testing	Legacy-waste canister SN-128, an HFEF-5 canister from MFC that contains SC debris, was flagged by RHINO while performing PA and WAC checks. Radionuclide inventories were evaluated and impacts were determined to be within the bounds of the PA. Dose consequences were evaluated in ECAR-6333 and determined to be within the bounds of the safety basis. The canister was deemed acceptable for disposal. No further action required.	Positive	Negative	Approved	None	None
UDQE-RHLLW-065	Vault shield plugs with Level 3 or greater damage identified during 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. Repairs are scheduled for FY 2023 and the UDQE will be completed after the repairs are made and approved by a qualified inspector. All four VSPs were determined to be operable with respect to the safety significant component criteria of SAR-419.	In Progress	In Progress	In Progress	TBD	TBD
UDQE-RHLLW-066	CVAS exhibiting Level 3 or greater damage identified during 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. Repair is scheduled for FY 2023 and the UDQE will be completed after the repair is made and approved by a qualified inspector. The HFEF CVAS was determined to be operable with respect to the safety significant component criteria of SAR-419.	In Progress	In Progress	In Progress	TBD	TBD

N/A indicates an evaluation was not required due to a negative screen.
a. UDQES/UDQEs are presented sequentially without regard to status. Identification numbers missing from the sequence were completed in a previous FY.
b. "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 management and operation contractor, Battelle Energy Alliance, LLC (BEA), for DOE Idaho Operations Office (DOE-ID) and is designated for government-controlled industrial use (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 DOE Naval Reactor (DOE-NR) programs managing naval spent fuel. Land use for the INL Site is further described in the *INL Comprehensive Land Use and Environmental Stewardship (CLUES) Report Update* (INL 2020b), and the *INL Site-Wide Institutional Controls, and Operations and Maintenance Plan for CERCLA Response Actions* (DOE-ID 2022). The RHLLW Disposal Facility and associated long-term controls were incorporated into the updated CLUES report. A review of the CLUES report was conducted in FY 2022 and determined current 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. Currently, no impacts to the PA, CA, or closure plan are anticipated based on the information reviewed (see Table 2, UDQE-RHLLW-056).

A number of recent congressional actions,[g] DOE-ID site-use permits,[h] construction of new nuclear energy research infrastructure at INL, and DOE's interpretation of the definition of the statutory term *high-level radioactive waste*[i] 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 more information becomes available.

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 most likely will remain essentially the same as the current use (INL 2020b). Other potential, but less likely land uses within the INL Site include agricultural use and the return of areas to their natural, undeveloped state.

Future land use identified in the CA is consistent with the most current land use plans for the INL Site. As of FY 2022, no changes are needed to ensure the continued adequacy of the CA with respect to land use assumptions.

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[g] 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 named INL as the National Reactor Innovation Center (NRIC) for DOE-NE. NRIC provides access and resources to private sector technology developers for testing, demonstration, and performance assessment to accelerated 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 on INL under DOE, DOD, or NRC rules.

[h] Use Permit No. DE-NE7000065, Use Permit Authorized by USDOE to Utah Associated Municipal Power Systems (UAMPS) (2016); Use Permit No. DE-NE700105, Use Permit Authorized by US DOE to Oklo Inc (2019).

[i] Federal Register Notice 83 FR 50909, October 10, 2018, requested public comments on the *US DOE Interpretation of High-Level Radioactive Waste*; followed by Federal Register Supplemental Notice 84 FR 26835 (June 10, 2019) in response to the October 10, 2018 FR Notice. Re-classification of a HLW stream requires implementation of the NEPA process.

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 issued in FY 2018, and no modifications to the WAC were made in FY 2022. A revision of the WAC may be necessary depending on the outcome of UDQE-RHLLW-063 that is expected to be completed in FY 2023 (see Section 2.7).

2.4 Impact of Future Disposals

Fifteen waste canister disposals were performed in FY 2022 at the RHLLW Disposal Facility. No changes in the waste forms are expected for future disposals. Future disposals at the RHLLW Disposal Facility are projected to come from the ATR Complex, NRF, and MFC, as stated in Section 1.1, and are to be within the constraints of the ODAS (ODAS 2018). However, the only waste streams currently approved for disposal are generated at MFC (see Section 4.1).

2.5 Composite Analysis Inventory and Waste Form

The sources of contamination considered in the composite analysis (CA) are still valid, and no new significant sources have been identified. With one exception, no modifications have been made or are expected to be made to the inventory of the residual radioactive material that was used as a basis for the CA. The exception is the Idaho Nuclear Technology and Engineering Center Calcined Solids Storage Facility. The PA and CA for this facility is currently being reviewed by the DOE Low-Level Waste Disposal Facility Federal Review Group (LFRG). Once the reviews are complete (anticipated FY 2023) and the PA and CA approved, they will be reviewed to determine potential impacts on the RHLLW Disposal Facility CA.

PLN-3368 includes a requirement to evaluate the potential impact of published INL Site Comprehensive Environmental 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 2021a). A review of DOE-ID (2021a) was conducted and found no information that could potentially impact the validity or conclusions of the RHLLW Disposal Facility PA or CA. This is documented in UDQE-RHLLW-055 (see Table 2).

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 disposal 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 2022, UDQE-RHLLW-063 was initiated to address a request by NRF Waste Programs for a permanent exception to limits of removable surface contamination on the exterior of waste canisters shipped to the RHLLW Disposal Facility as specified in the WAC (PLN-5446). A determination on UDQE-RHLLW-063 and the special analysis (if necessary) is expected in FY 2023. If the special analysis is approved, a WAC revision will be required.

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. The facility PA and CA will be updated if the facility is expanded. During FY 2022, there were no changes in the design, construction, or operation of the RHLLW Disposal Facility.

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 *Conduct of RHLLW Disposal Facility Waste Generator Facility Evaluations* (MCP-4211). 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 identifying conditions adverse to quality.

A successful re-certification for the only currently approved waste generator (MFC) was conducted in FY 2022 and the results are documented in ASMT-2022-0078. An initial waste generator certification assessment for NRF was initiated in FY 2022 (ASMT-2022-0618) and is expected to be completed in FY 2023. Waste shipments from NRF are anticipated to begin in FY 2023. An initial waste generator certification of ATR Complex Waste Programs is expected to begin in FY 2023.

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:

- 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 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 2022. DOE-STD-1196 was updated in FY 2021 (DOE-STD-1196-2021) to provide derived concentration standards and new dose coefficients for the ingestion of water, inhalations and submersion in air, in a manner reflecting the current state of knowledge and practice in radiation protection. The RHLLW Disposal Facility PA was based on values from the previous standard (DOE-STD-1196-2011), which is the standard invoked by the current DOE O 458.1. During FY 2022, the RHLLW Disposal Facility was in the process of evaluating the updated standard with respect to potential impacts to the PA. During that evaluation it was determined that there were some minor errors in derived concentration standards in the updated 2021 standard. As a result, the 2021 standard was updated in December 2022 (FY 2023) (DOE-STD-1196-2022), and the 2022 update will be evaluated in FY 2023 for potential impacts to the PA.

A summary of waste disposal records is presented and discussed in Section 4. Groundwater-pathway compliance and performance-monitoring data is presented and discussed in Section 5. A review of on-site 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. Hydraulic drainage system-performance data are reviewed annually only to support lysimeter sampling.

2.9.2 Documentation Updates

Table 1 of 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. The only technical-basis documents to be revised since issuance of the ODAS are the monitoring plan (PLN-5501) in FY 2020, the PA/CA maintenance plan (PLN-3368) in FY 2021, and the change control process document (RH-ADM-5214, formerly SD-52.1.4) in FY 2022. The monitoring plan and PA/CA maintenance plan revisions were addressed in the FY 2020 and FY 2021 ASRs.

RH-ADM-5214 was updated in FY 2022 to include mandatory UDQSs of all RHINO SCRs consistent with the decision discussed in the FY 2019 ASR (INL 2020). SCRs completed previous to the change were evaluated in UDQE-RHLLW-042 (see FY 2020 ASR, INL 2021), and UDQE-RHLLW-044 (see FY 2021 ASR, INL 2022). Additionally, RH-ADM-5214 was changed from a sitewide standing directive (SD) to a facility administrative procedure document (ADM) at the request of the MFC associate laboratory director. This involved formatting changes and a new document number.

Other relevant document updates in progress include *Technical Basis for Environmental Monitoring and Surveillance at the INL Site* (DOE-ID 2014) and the *Idaho National Laboratory Environmental Monitoring Plan* (DOE-ID 2021b). These documents will include monitoring activities associated with the RHLLW Disposal Facility. Both revisions are expected to be completed in FY 2023.

Work that would form the basis for a special analyses was initiated in FY 2022 (see Section 2.7). A determination on UDQE-RHLW-063 and the special analysis (if necessary) is expected in FY 2023. If the special analysis is approved, a WAC revision will be required.

2.9.3 Planned and As-Needed Maintenance Activities

Table 1 of the PA/CA maintenance plan 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 activity directed by Model Work Order (MWO) 260064 (2018). The 2022 inspection was performed under annual Work Order (WO) 325548 (2022). 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 one indication of animal nesting or burrowing on the southeast end of the yard near staged equipment; this issue has been corrected. Some minor vegetation was present, which was either corrected on the spot or eradicated by maintenance personnel spraying weed control. In addition, 10 random locations throughout the vault yard near the vault arrays were tested for compaction. All locations showed compaction measurements met or exceeded 95% criteria from the design specification of 95% of maximum dry unit weight per ASTM D698.

VSPs are also inspected annually for damage. These activities are directed by MWO 257898 (2018) and were performed in 2022 under annual WOs 327459 and 325548 (2022). 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.

Four VSPs in vault array 2 (C1, D1, E1 and E2) were found to have damage exceeding the Level 3 criteria of the WO. VSP C1 exhibited a chip on the top corner; VSP D1 exhibited one chip area and two cracks; VSP E1 exhibited a crack; and VSP E2 exhibited a chip. These damages were evaluated in OPR 2022-0185 and OPR 2022-0248 (2022), which were generated from CO 2022-1236 and CO 2022-1589 (2022), respectively, to determine their functionality with respect to SAR-419 safety analysis requirements. The results of these evaluations showed all four VSPs can still perform their safety function. Additionally, these VSPs were being evaluated under UDQE-RHLLW-065 (see Table 2) for concerns relative to the PA/CA at the end of FY 2022. Even though the four VSPs were declared acceptable for continued use, it is Engineering's posture to perform repairs under the routine repair WO to ensure VPSs can be expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance. As such, maintenance work request MWR-2022-4857 (2022) was submitted to initiate these repairs under the routine WO covering this work.

Table 1 of 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 or diversion dam was inspected in the fall of 2021 and the spring 2022. 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 work order packages:

- PM Radioactive Waste Management Complex Diversion Dam Semi-Annual Floodgate Inspection (WO Package 313147, 2021) performed September 2021.
- PM Radioactive Waste Management Complex Diversion Dam Semi-Annual Floodgate Inspection (WO Package 321082, 2022) performed March 2022.
- PM Experimental Breeder Reactor-II Semi-Annual Floodgate Inspection (WO Package 314687, 2021) performed October 2021.

- PM Experimental Breeder Reactor-II Semi-Annual Floodgate Inspection (WO Package 322718, 2022) performed April 2022.
- PM Lost River Sinks Semi-Annual Floodgate Inspection (WO Package 314693, 2021) performed October 2021.
- PM Lost River Sinks Semi-Annual Floodgate Inspection (WO Package 322717, 2022) performed April 2022.
- PM Howe Semi-Annual Pole Line Road Floodgate Inspection (WO Package 314684, 2021) performed October 2021.
- PM Howe Semi-Annual Pole Line Road Floodgate Inspection (WO Package 322716, 2022) performed April 2022.

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. Several projects at the nearby ATR Complex that were initiated, continued, or completed in FY 2022 were evaluated. These include the:

- Completion and turnover of the upgrade to the Nuclear Materials Inspection and Storage facility
- Continued construction of the new ATR Reactor Support Building, a general office building that will contain a cafeteria
- ATR West Drainage Improvements, a grading project designed to prevent stormwater from entering utility vaults on the west side of the facility
- Completion and turnover of the upgrade to the ATR Complex Cold Waste pumps control system that conveys wastewater to the Cold Waste Ponds
- ATR Core Internals Changeout (CIC) VI.

Except for the ATR CIC, wastewater generated from the projects consists of sanitary sewer wastewater discharged to lined treatment lagoons or storm runoff. Each of the building construction projects incorporate general stormwater management features such as swales, ponds, or shallow injection wells for runoff control. The largest contributor to the perched water body below the ATR Complex is the Cold Waste Pond. The Cold Waste Pond upgrade improves the pump-controller system but does not impact flows to or function of the ponds. While the ATR CIC VI contributed to a total Cold Waste Pond discharge greater than the previous FY, the total FY 2022 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. No corrective maintenance regarding either was required in FY 2022.

3. CUMULATIVE EFFECTS OF CHANGES

As described in Section 2, there were no changes identified in FY 2022 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), an annual facility evaluation (FE) (see Section 2.9.1) was conducted in FY 2022 to re-certify MFC's waste certification program and waste streams are compliant with the WAC (PLN-5446). The FE was conducted according to MCP-4211 (2020) and documented in ASMT 2022-0078. As a result, current waste streams approved for shipment and disposal to the RHLLW Disposal Facility are:

- Activated metals in HFEF-5 canisters from MFC
- Surface-contaminated (SC) debris in HFEF-5 canisters from MFC
- Combined activated metals and SC debris in HFEF-5 canisters from MFC.

Initial waste generator certification of NRF as a generator of 55-ton waste canisters containing activated metals and SC debris began in FY 2022 and is expected to be completed in FY 2023. Initial waste generator certification of ATR Complex as a generator of ATR-5 waste canisters containing activated metals is expected to begin in FY 2023.

4.2 Waste Receipts

During FY 2022, 15 waste canisters were received and disposed of in the RHLLW Disposal Facility. Table 3 contains information on these 15 canisters including container type, waste form, disposal date, and disposal location.

Table 3. Waste receipts and disposals in FY 2022.

Generator	Generator Canister ID No.	Container Type	Waste Form[a]	Shiptask No.	Waste Receipt Date	Disposal Date	Vault Array	Disposal Position
MFC	MFC210277	HFEF-5	Combined	RHLLW-MFC-22-001	12/15/2021	1/25/2022	HFEF	02-D01-5b (Top)
MFC	SN-142	HFEF-5	AM	RHLLW-MFC-22-002	6/2/2022	6/6/2022	HFEF	02-D01-6a (Bottom)
MFC	SN-106	HFEF-5	AM	RHLLW-MFC-22-003	6/7/2022	6/8/2022	HFEF	02-D01-6b (Top)
MFC	OWC034	HFEF-5	AM	RHLLW-MFC-22-004	6/9/2022	6/14/2022	HFEF	02-D02-1a (Bottom)
MFC	OWC036	HFEF-5	AM	RHLLW-MFC-22-005	6/16/2022	6/20/2022	HFEF	02-D02-1b (Top)
MFC	SN-104	HFEF-5	SC	RHLLW-MFC-22-006	6/21/2022	6/22/2022	HFEF	02-D02-2a (Bottom)
MFC	SN148	HFEF-5	SC	RHLLW-MFC-22-007	6/23/2022	6/30/2022	HFEF	02-D02-2b (Top)
MFC	SN-130	HFEF-5	Combined	RHLLW-MFC-22-008	7/25/2022	7/26/2022	HFEF	02-D02-3a (Bottom)
MFC	MFC110124	HFEF-5	Combined	RHLLW-MFC-22-009	8/8/2022	8/9/2022	HFEF	02-D02-3b (Top)
MFC	MFC080004 (SN-180)	HFEF-5	Combined	RHLLW-MFC-22-010	8/9/2022	8/10/2022	HFEF	02-D02-4a (Bottom)
MFC	SN-134	HFEF-5	SC	RHLLW-MFC-22-011	8/11/2022	8/16/2022	HFEF	02-D02-4b (Top)
MFC	SN-107	HFEF-5	SC	RHLLW-MFC-22-012	8/30/2022	8/31/2022	HFEF	02-D02-5a (Bottom)
MFC	SN-81	HFEF-5	SC	RHLLW-MFC-22-013	9/1/2022	9/6/2022	HFEF	02-D02-5b (Top)
MFC	SN-139	HFEF-5	Combined	RHLLW-MFC-22-014	9/13/2022	9/20/2022	HFEF	02-D02-6a (Bottom)
MFC	SN-128	HFEF-5	SC	RHLLW-MFC-22-015	9/27/2022	9/28/2022	HFEF	02-D02-6b (Top)

a. AM = Activated Metals, SC = Surface-Contaminated Debris, Combined = Activated Metals and Surface-Contaminated Debris.

The HFEF vault array (Array 02) consists of 15 vaults with positions for 12 canisters in each vault, resulting in a total capacity of 180 canisters from MFC and ATR Complex. Four of the 15 canisters placed in FY 2022 contained only activated metals, six contained only SC debris, and five contained combined activated metals and SC debris. Fourteen of the canisters were legacy-waste canisters from the Radioactive Scrap and Waste Facility, and one (Canister ID MFC210277) was a new-generation (non-legacy) HFEF-5 canister from the Fuel Conditioning Facility (FCF) at MFC.

A summary of the canisters placed, and facility capacity are presented in Table 4. This contains the vault capacity, the percentage of vaults/positions and total vaults/positions filled through FY 2022. Table 5 contains a summary of the volume of canisters placed in the vaults.

Table 4. Vault capacity summary through FY 2022.

Array	Vault Type	Vault Description	Positions Filled FY 2022	Positions Filled Cumulative Through FY 2022	Empty Positions Remaining Through FY 2022	Total Positions	Percent Positions Filled Through FY 2022
01	NuPac	1 Hole (2 Levels)	0	0	120	120	0.0%
02	HFEF-5	6 Holes (2 Levels)	15	60	120	180	33.3%
	LCC	1 Hole (Single Storage)	0	0	195	195	0.0%
03	55-ton	1 Hole (2 Levels)	0	0	168	168	0.0%
04	Modified FTC	3 Holes (1 Level)	0	0	276	276	0.0%
Facility Totals			15	60	879	939	6.4%

Table 5. Placed canister volume summary through FY 2022.

Array	Vault Type	Canister Type, Generator, Waste Form	Generator	Gross Volume (m^3) FY 2022	Cumulative Gross Volume (m^3) Through FY 2022
02	HFEF-5	HFEF-5 - MFC Activated Metals w/ lead plug	MFC	0	0.462
		HFEF-5 - MFC Activated Metals w/ steel plug	MFC	0.616	4.158
		HFEF-5 - MFC Combined w/ lead plug[a]	MFC	0.154	0.462
		HFEF-5 - MFC Combined w/ steel plug[a]	MFC	0.462	2.926
		HFEF-5 - MFC Surface Contaminated w/ lead plug	MFC	0.154	0.154
		HFEF-5 - MFC Surface Contaminated w/ steel plug	MFC	0.924	1.078
		Array Total		2.31	9.24
Facility Totals				2.31	9.24

a. Waste form is combined activated metals and surface-contaminated debris.

4.3 Radionuclide Inventory Tracking Using RHINO

A running total of radionuclide activities by vault array, generator, and waste form is recorded and tracked using the facility-inventory management system, RHINO (TFR-981 2018). In the 15 HFEF-5 waste canisters placed in FY 2022, there were 19 radionuclides reported in activated metals and 122 radionuclides reported as surface contamination. Nine radionuclides were reported as both activated metal and surface contamination. Nine of 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 were evaluated using the UDQE process (see Section 2.1). Radionuclide reporting requirements are documented in the WAC (PLN-5446).

Dose calculations and canister-acceptance checks were performed by RHINO based on the reported activities of the 14 radionuclides fully analyzed in the PA for the groundwater pathway, the five radionuclides that account for 99% of the chronic-intruder dose (limiting intruder scenario), and the three radionuclides considered in the final air-pathway screening in the PA. The air pathway was screened out in the PA, but the three radionuclides 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 6 contains the inventory placed in FY 2022 and cumulative inventory for the groundwater-pathway radionuclides fully analyzed in the PA. These are recorded and presented by array, generator, and waste form. Only Cl-36 was not reported in any of the FY 2022 disposals.

Given the total number of HFEF-5 canisters placed through FY 2022 is 33.3% of the HFEF-vault array capacity (Table 4), the cumulative inventory of this vault array as a percent of the PA inventory is approximately as expected or less than expected for seven of the 14 groundwater-pathway radionuclides fully analyzed in the PA. The large percentages of Np-237 (2626%), Pu-240 (951%), U-238 (141%), U-235 (137%), and Pu-239 (85%) are due primarily to larger than expected inventories in the new-generation (non-legacy) waste canister MFC210277 from FCF at MFC. This canister was flagged by RHINO for exceeding the 10% PA inventory threshold of several radionuclides for the specific generator/canister/waste form and evaluated for disposal acceptance in UDQE-RHLLW-053. The large percentages of H-3 (82.6%) and I-129 (908%) are from larger than expected inventories in canisters SN-148 and MFC110124, respectively. Canister MFC110124 is actually the first canister to report I-129. These two canisters were flagged by RHINO and were evaluated for disposal acceptance in UDQE-RHLLW-061.

Although the inventories of several radionuclides in the HFEF-vault array exceed what is expected for this generator/canister/waste form according to the PA, the inventories are small compared to the total PA inventories for all generators and canisters. This explains why the projected all-pathway dose contributed by these radionuclides is not significant with respect to performance objectives (Section 4.3).

The discrepancy between actual inventories and PA base-case inventories for new-generation waste is likely related to the generating facility at MFC and the waste type. The four canisters of new-generation waste at the RHLLW Disposal Facility were loaded at the FCF. Of the 23 waste canisters used to estimate the inventory of new-generation waste for the PA, 22 were loaded with waste from the Hot Fuel Examination Facility (HFEF) hot cell and one from FCF. These were the most recently loaded waste canisters at MFC prior to developing the source term for the PA. Although the cell waste at both HFEF and FCF are similar, there are some differences that could explain the discrepancy. For example, both facilities contain irradiated metals and hardware from Experimental Breeder Reactor-II, but HFEF contains more post-irradiation-examination research waste categorized as combination waste (activated metal and SC debris). Because of this discrepancy, the inventory projections of legacy and new-generation waste from MFC are being evaluated. This evaluation began in FY 2022 and is expected to be completed in FY 2023.

Table 6. Radionuclide activities disposed of by array, generator and waste form through FY 2022 compared to inventory analyzed in the PA for the groundwater pathway.

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2021 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
C-14	55-ton	NRF	A			4.78E+01	
			R			2.36E-02	
			S			8.09E-01	
	HFEF-5	ATR	A			2.36E+01	
		MFC	A	5.05E-02	5.50E-01	2.75E+00	20.0%
	Large Concept Cask	NRF	A			1.12E+02	

Table 6. (Continued.)

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2021 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
			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			2.21E-02	
	HFEF-5	ATR	A			3.40E-06	
	Large Concept Cask	NRF	A			9.24E-02	
H-3	55-ton	NRF	A			6.12E+01	
			R			1.14E+00	
	HFEF-5	ATR	A			1.76E+03	
		MFC	A	3.18E-01	3.19E-01	1.21E+01	2.63%
			S	1.15E-05	2.88E-05	3.49E-05	82.6%
	Large Concept Cask	NRF	A			1.47E+02	
			R			2.61E+00	
	NuPac	ATR	R			1.09E-01	
I-129	55-ton	NRF	A			2.14E-06	
			R			5.52E-07	
			S			2.66E-06	
	HFEF-5	ATR	A			2.47E-15	
		MFC	S	4.00E-08	4.00E-08	4.40E-09	908%
	Large Concept Cask	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			2.11E-01	
	HFEF-5	ATR	A			5.41E-01	
		MFC	A	2.14E-01	1.25E+00	2.78E+00	45.0%
	Large Concept Cask	NRF	A			2.61E-01	
	Modified FTC	MFC	A			2.17E+01	
			S			3.19E-01	
Nb-94	55-ton	NRF	A			3.71E+00	
			R			6.16E-10	
			S			1.15E-02	
	HFEF-5	ATR	A			3.82E+01	
		MFC	A	3.11E-01	4.53E-01	1.11E+00	40.9%
	Large Concept Cask	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			5.83E+02	
			R			3.39E+00	
			S			3.16E-01	
	HFEF-5	ATR	A			1.90E+02	

Table 6. (Continued.)

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2021 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
		MFC	A	4.65E-01	2.14E+00	8.85E+00	24.1%
	Large Concept Cask	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			1.76E-06	
			R			4.49E-06	
			S			3.35E-09	
	HFEF-5	MFC	S	1.46E-06	1.80E-06	6.86E-08	2626%
	Large Concept Cask	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			6.60E-02	
			R			3.09E-05	
			S			7.04E-05	
	HFEF-5	MFC	S	1.21E-02	1.33E-02	1.56E-02	84.9%
	Large Concept Cask	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			5.67E-02	
			R			6.31E-05	
			S			6.22E-05	
	HFEF-5	MFC	S	4.74E-04	5.81E-04	6.11E-05	951%
	Large Concept Cask	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			3.54E-02	
			R			1.69E-02	
			S			1.43E-03	
	HFEF-5	ATR	A			2.58E-02	
		MFC	A	6.28E-03	1.58E-02	0.00E+00[c]	NA[c]
			S	5.73E-02	1.16E-01	5.36E-01	21.6%
	Large Concept Cask	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			2.64E-05	
			R			8.28E-05	

Table 6. (Continued.)

Nuclide	Vault Array	Waste Generator	Waste Form[a]	FY 2021 Inventory (Ci)	Cumulative Inventory (Ci)	PA Inventory (Ci)[b]	Cumulative Inventory as % of PA Inventory
			S			4.78E-07	
	HFEF-5	MFC	S	7.81E-05	9.42E-05	1.17E-04	80.3%
	Large Concept Cask	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			4.49E-07	
			R			1.11E-06	
			S			1.57E-10	
	HFEF-5	MFC	S	1.90E-06	2.48E-06	1.81E-06	137%
	Large Concept Cask	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			3.10E-05	
			R			5.13E-09	
			S			1.40E-08	
	HFEF-5	MFC	S	1.04E-06	1.29E-06	9.11E-07	141%
	Large Concept Cask	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). They are combined because both are treated the same for calculating the all-pathway PA dose.

c. 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 7 presents the FY 2022 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 vault-array action level at 14.4%. Given the total number of HFEF-5 canisters placed through FY 2022 is 33.3% of the HFEF-vault array capacity (Table 4), the cumulative inventory of these two radionuclides are presently not a cause for concern, but the percentages will continue to be monitored.

Table 7. Radionuclide inventory of primary dose contributors to the chronic-intruder pathway through FY 2022.

Nuclide	Vault Array	FY-2022 Inventory (Ci)	Cumulative Inventory Through FY 2022 (Ci)	Vault Array Action Level[a] (Ci)	Cumulative Inventory Through FY 2022 as % of Vault Array Action Level
Co-60	55-ton			7.33E+05	
	HFEF-5	8.32E+01	7.67E+03	3.79E+06	0.20%
	Large Concept Cask			1.17E+06	
	Modified FTC			2.68E+04	
	NuPac			4.24E+03	
Cs-137	55-ton			1.27E+02	
	HFEF-5	7.68E+00	8.83E+00	6.12E+01	14.4%
	Large Concept Cask			2.76E+02	
	Modified FTC			1.69E+04	
	NuPac			1.14E+02	
Nb-94	55-ton			6.88E+01	
	HFEF-5	3.11E-01	4.53E-01	7.27E+02	0.06%
	Large Concept Cask			1.57E+02	
	Modified FTC			8.90E+01	
	NuPac			1.57E+01	
Ni-63	55-ton			1.36E+06	
	HFEF-5	4.01E+01	1.37E+02	4.68E+05	0.03%
	Large Concept Cask			2.11E+06	
	Modified FTC			8.64E+04	
	NuPac			6.29E+02	
Sr-90	55-ton			8.53E+01	
	HFEF-5	1.67E+01	1.80E+01	1.25E+02	14.4%
	Large Concept Cask			1.92E+02	
	Modified FTC			1.17E+04	
	NuPac			3.00E+02	

a. Vault-array action levels (Engineering Calculations and Analysis Report (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[j] 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 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 *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 because, 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 8 summarizes the performance measures for all disposals in FY 2022 and cumulative disposals through FY 2022. As expected, the calculated dose and concentration performance measures for all canisters placed through FY 2022 are a very 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.

RHINO tracks contributions to the all-pathway dose by vault array, generator, and waste form. As other vault arrays are utilized in the future, this information will be presented in future ASRs. For now, the entire all-pathway dose is attributed to the MFC waste in the HFEF-vault array. Although the FY 2022 waste and cumulative waste disposed of through FY 2022 consists of both activated metals and surface contamination, the dose was dominated by the surface contamination.

The PA reported the projected radionuclide inventories from all waste generators. Disposal inventories for the 20-year facility life cycle were projected for each of the waste generators and compiled in ECAR-3940 (2018). This ECAR informed the source term used in the facility PA. Although there have been some deviations from the projected facility source term evaluated in the PA (ECAR-3940), the total projected dose remains bounded by the PA analysis.

[j] 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 based on its limit derived from the PA. It is calculated by dividing each nuclides 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 8. Summary of facility performance through FY 2022.

Performance Objective or Measure	Performance Standard	Point of Assessment Location	Compliance Period			Post-Compliance Period		
			Maximum Based on FY-2022 Disposals	Maximum Based on Cumulative Disposals Through FY 2022	Cumulative Disposal Maximum as % of Standard	Maximum Based on FY-2022 Disposals	Maximum Based on Cumulative Disposals Through FY 2022	Cumulative Disposal Maximum as % of Standard
All-Pathway Dose	25 mrem/yr	100 m	4.68E-05	9.45E-05	0.0004%	2.72E-02	5.50E-02	0.22%
Air-Pathway Dose[a]	10 mrem/yr	100 m	6.19E-08[b]	6.66E-07[b]	0.00001%[b]	NA[c]	NA[c]	NA[c]
Intruder Dose	100 mrem/yr	Facility	4.23E-02	5.13E-02	0.051%	NA[c]	NA[c]	NA[c]
Beta-gamma DE[d]	4 mrem/yr	100 m	3.32E-05[e]	6.71E-05[e]	0.002%[e]	1.93E-02[e]	3.91E-02[e]	0.98%[e]
Beta-gamma ED[d]	4 mrem/yr	100 m	1.82E-05[e]	3.67E-05[e]	0.0009%[e]	1.06E-02[e]	2.14E-02[e]	0.53%[e]
Gross alpha	15 pCi/L	100 m	1.61E-30	1.96E-30	0.00%	3.25E-06	3.97E-06	0.00003%
Ra-226/228	5 pCi/L	100 m	7.49E-33	9.04E-33	0.00%	7.00E-07	8.44E-07	0.00002%
Uranium Mass	30 ug/L	100 m	4.74E-28	5.93E-28	0.00%	9.08E-06	1.13E-05	0.00004%

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. Cl-36 was not reported in FY 2022 or any other previous year.

5. MONITORING

Compliance and performance monitoring began in FY 2019 with commencement of operations of the facility and is conducted in accordance with 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 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 establish background concentrations and evaluate facility performance. Data from subsurface moisture and temperature sensors are monitored to determine favorable conditions for lysimeter sample collection, as needed. Aquifer and lysimeter sample results 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 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, from Calendar Year 2021 (DOE-ID 2022), indicate gross alpha and gross beta were detected in concentrations consistent with historical measurements. 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-1196-2011).

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 325548 (2022) for Calendar Year 2022. 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. The inspection identified one location at the southeast sector of the yard that showed evidence of a burrowing animal under a piece of staged equipment. The issue has been corrected.

The only other monitoring activities performed at the facility are annual visual inspections of the vault-yard road apron, topographic survey and compaction measurements, and inspection of VPSs for damage. The road-apron inspection showed typical rutting, settling, erosion, sedimentation, and uneven surfaces; however, all 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 topographic survey and compaction measurements were completed and show there are no significant issues and only typically expected changes from initial configuration/conditions. 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 chip/spall that required repair. Repairs are planned for FY 2023 (see Section 2.9.3.1). Any damage and repairs (if necessary) are managed using the change-control process (RH-ADM-5214). UDQEs associated with vault damage or repairs are presented in Section 2.1. Two vaults (see Figure 1 through 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 4). 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 semi-annual. Although, the performance-monitoring action levels only apply after the 3-year period to establish baseline concentrations, semi-annual groundwater sampling was performed in FY 2022. As discussed in Section 5.2, the 3-year period was extended due to a preliminary determination that there was insufficient data from the 3-year period to establish baseline concentrations.

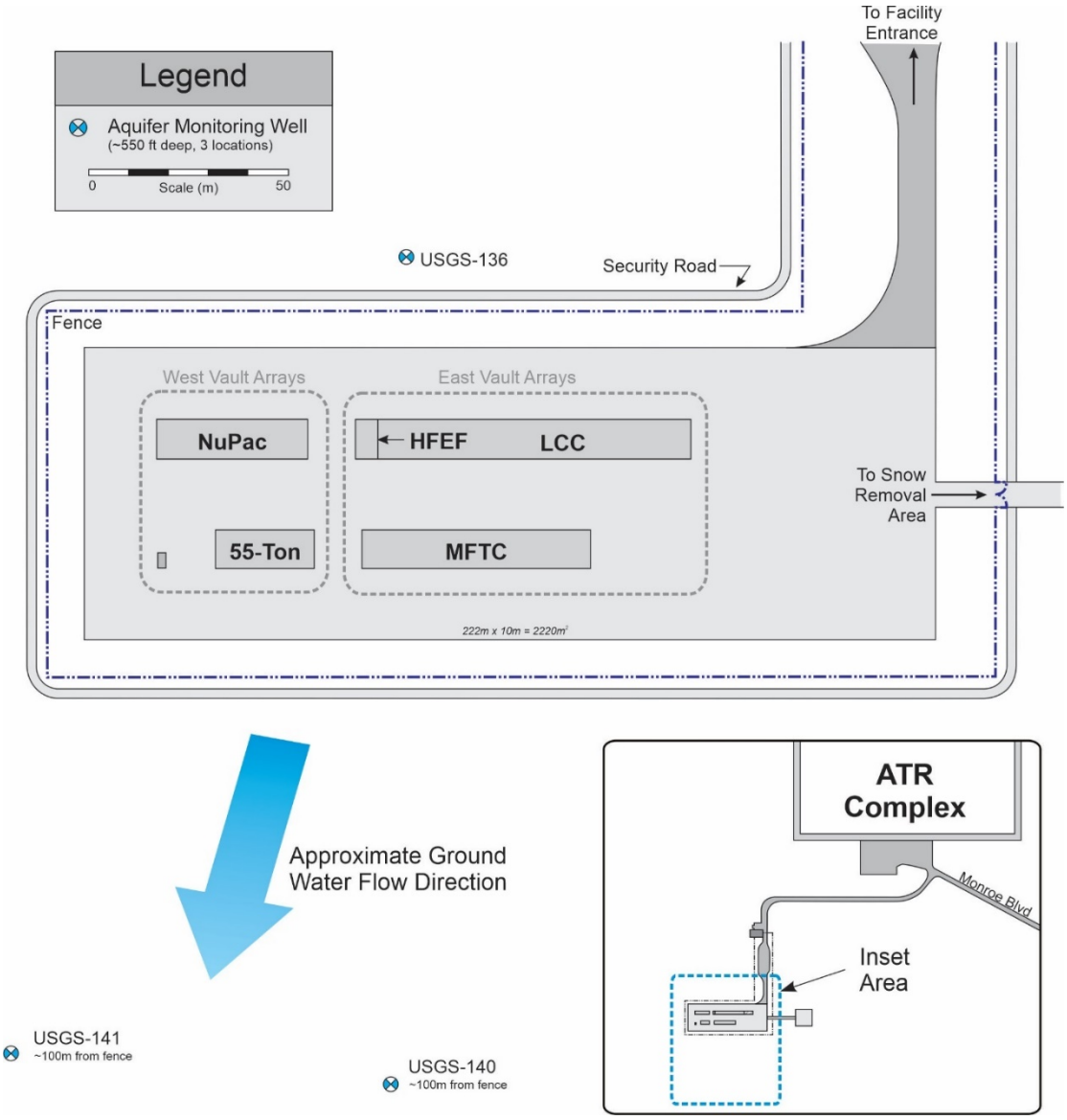

Figure 4. RHLLW Disposal Facility layout showing aquifer-monitoring well locations.

Table 3 of PLN-5501 lists 14 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 were selected as target analytes (e.g., H-3, C-14, Tc-99, and I-129) due to the largest degree of mobility and predicted impact on the aquifer and 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 and September 2022. Results of the compliance monitoring are presented in Appendix B and summarized in Table 9. Tritium (H-3) was detected in all three aquifer wells and concentrations continue to exhibit a decreasing trend since 2018, consistent with regional trends observed in DOE-ID (2021). Gross beta was positively detected in all three wells in FY 2022, 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 2022, C-14, I-129, and Tc-99 were not detected in any samples from the three wells. All results are consistent with concentrations in the aquifer established prior to facility completion (INL 2017) (see Appendix B).

5.2 Performance Monitoring

Performance monitoring of the facility is achieved by analysis of soil-porewater samples collected from vadose zone lysimeters. All lysimeters are installed adjacent to vault arrays (see Figure 5) 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). The monitoring plan specifies that sample collection from vadose zone monitoring points is only required when sufficient porewater is present and can be collected.

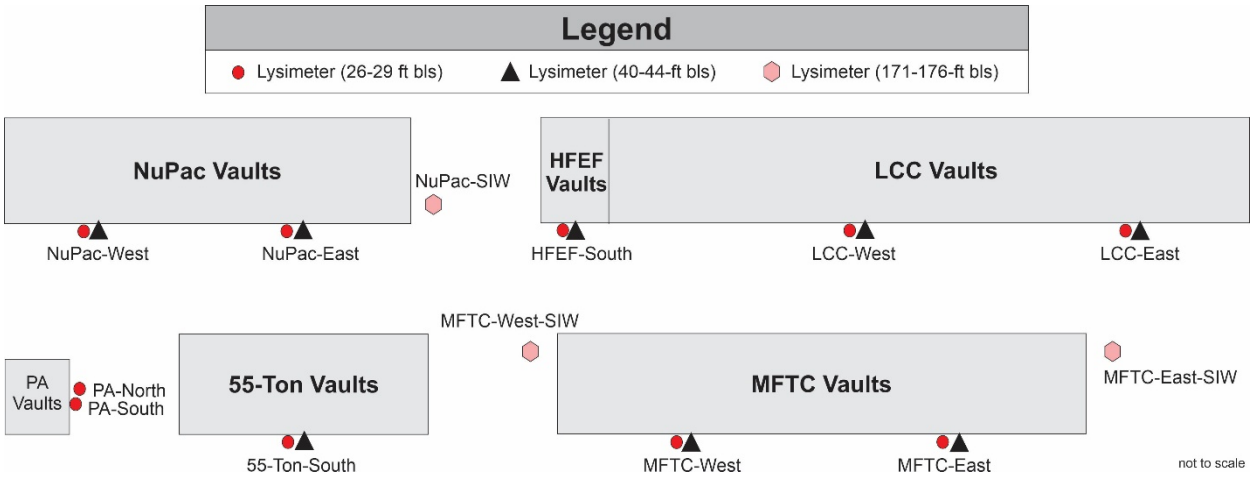

Figure 5. Plan view of the vault arrays showing the lysimeter locations.

FY 2019 began a 3-year period to establish baseline concentrations for all lysimeters. During this period, samples were to be collected annually and analyzed for the same target and indicator analytes as the aquifer samples. Approximately 530–730 mL of sample is required for the full suite of analytes. In the event of insufficient porewater for full analysis, the precedence for analysis is gross alpha/beta, C-14, I-129, H-3, and then Tc-99. After the 3-year baseline period, the monitoring plan specifies that annual sampling be conducted only at lysimeters near vaults that have received waste, and samples will be analyzed only for indicator analytes, gross alpha and gross beta (as sample volumes permit). Annual sampling will continue as long as positive detections of either gross alpha or gross beta do not exceed action levels at any of the monitoring locations. If gross-alpha or gross-beta action levels are exceeded, as shown through trend analysis, sampling frequency will be increased to semi-annually (as soil water is available) and continue as long as action levels are exceeded. Semi-annual samples will be analyzed for target analytes H-3, C-14, Tc-99, and I-129, in addition to gross alpha and gross beta.

A preliminary evaluation of lysimeter data collected during the 3-year period to establish baseline concentrations (FY 2019 through FY 2021) was performed in FY 2022 prior to collection of samples in the spring. This evaluation determined that insufficient data had been collected to determine baseline concentrations for several lysimeters and analytes (see Appendix B, Table B-6). As a result, the baseline period was extended and routine sampling was performed in FY 2022. However, analyte priorities were modified for specific lysimeters so that samples would be analyzed for analytes with less data.

Lysimeter sample collection for FY 2022 was performed in the spring (March 28 through May 3) similar to previous years. As in previous years, multiple sample collections were performed to increase the total sample volume from each lysimeter in hopes of having enough porewater to analyze for the full suite of analytes. After each sample-collection event, vacuum was reapplied to the lysimeters and samples collected again after 1 or 2 weeks. This process was repeated several times until sufficient porewater was obtained, or until the amount of water recovered became trivial.

In FY 2022, all 10 of the lysimeters in the shallow-alluvium yielded water, and sufficient volume was collected from five of the lysimeters for the full suite of analytes. Sufficient volume was collected from four of those lysimeters to perform duplicate analyses for one or more analytes.

In FY 2022, all eight lysimeters in the deep-alluvium yielded water, but similar to previous years, quantities were only enough to analyze for a few of the analytes. HFEF-South-45 yielded enough water to analyze for H-3 and Tc-99 while LCC-West-45 yielded enough for a gross alpha and gross-beta analysis. The other six lysimeters yielded only a small amount of water (20 to 87 ml), so the samples were combined and the total volume (239 ml) was analyzed for gross alpha and gross beta. All three of the deep lysimeters yielded water, but one (NuPac-SIW) produced only enough water to analyze for gross alpha and gross beta. Another produced enough to analyze for gross alpha, gross beta, and tritium. The third lysimeter yielded enough water for the full suite of analytes and duplicate analyses for three target analytes.

[k] Detection is defined as the result being 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. U and UJ-qualified data are not considered detections. J-qualified data are considered detections.

The routine spring lysimeter sampling collected sufficient water from all 10 shallow-alluvium lysimeter samples to analyze for gross alpha and gross beta. Of the ten samples, eight positively detected gross alpha, and nine detected gross beta. Gross alpha may have been detected in one other shallow-alluvium lysimeter, but the results were qualified UJ in the validation report. A UJ qualifier indicates the radionuclide may or may not be present in the sample, and the result is considered highly questionable. For this report, all data qualified as U (non-detect) or UJ are not reported as positive detections.[k] Both of the deep-alluvium lysimeter samples from the spring sampling were positive for gross alpha and gross beta. Again, one of these samples was a composite of samples from seven of the deep-alluvium lysimeters. All three spring samples from the sedimentary-interbed lysimeters were positive for both gross alpha and gross beta. Of all the spring lysimeter samples, C-14, I-129, and Tc-99 were not detected in any. Tritium was detected in five of the 10 shallow-alluvium lysimeters, down from seven the previous year. Tritium was detected in the only deep-alluvium lysimeter sample analyzed for tritium, and it was not detected in the two samples collected from the sedimentary-interbed lysimeters.

In addition to the routine annual lysimeter sampling in the spring, six lysimeters were sampled in the fall of 2021 (FY 2022) and analyzed for tritium and other analytes as sample volumes permitted. This "non-routine" sampling effort was conducted in response to an unexpectedly high tritium result from lysimeter HFEF-South in spring FY 2020. This is discussed in detail in Section 5.2.1 of the FY 2021 ASR (INL 2022). These six lysimeters include HFEF-South and five others near HFEF-South. Although there is no action level for tritium in soil porewater, the semi-annual sampling of these six lysimeters for tritium analysis will continue until the tritium concentration in lysimeter HFEF-South declines to less than the federal drinking water maximum contaminant level (MCL) of 20,000 pCi/L. The latest sample result from spring 2022, 27,000 pCi/L, is down from a high of 47,100 pCi/L in spring 2020.

All performance-monitoring results for FY 2022 are presented in Appendix B and summarized in Table 10. All sample concentrations were less than action levels, with two exceptions. The gross-alpha result from the PA-North lysimeter sample (11.1 pCi/L) exceeds the action level of 10 pCi/L. This result is consistent with the previous 3 years that were also slightly above the action level for this lysimeter. According to the monitoring plan (PLN-5501), this lysimeter is not scheduled to be sampled after baseline concentrations are established, because no waste will be placed in the vault near this lysimeter.

The other gross-alpha result that exceeded the action level was for the combined sample from six deep-alluvium lysimeters (17.9 pCi/L). This is slightly greater than a gross-alpha result in FY 2020 (11.6 pCi/L) from a composited sample from seven of the eight deep-alluvium lysimeters that also exceed the action level. Although some sample results exceed the performance-monitoring action level, action levels only truly apply after baseline concentrations have been established. Baseline concentrations are expected to be established in FY 2023.

Although action levels are only defined for gross alpha and gross beta, the tritium concentration in soil porewater from lysimeter HFEF-South exceeded the federal drinking water MCL of 20,000 pCi/L both in the fall of 2021 (32,800 pCi/L) and the spring of 2022 (27,000 pCi/L). The monitoring plan states that if gross alpha or gross beta action levels are exceeded, lysimeter samples will be analyzed for target analytes and the results will be compared to MCLs. The tritium results in FY 2022 were greater than the MCL but less than the 47,100 pCi/L result from spring 2020, and FY 2022 results continue to exhibit a downward trend since that result (see Figure 6).

[k] Detection is defined as the result being 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. U and UJ-qualified data are not considered detections. J-qualified data are considered detections.

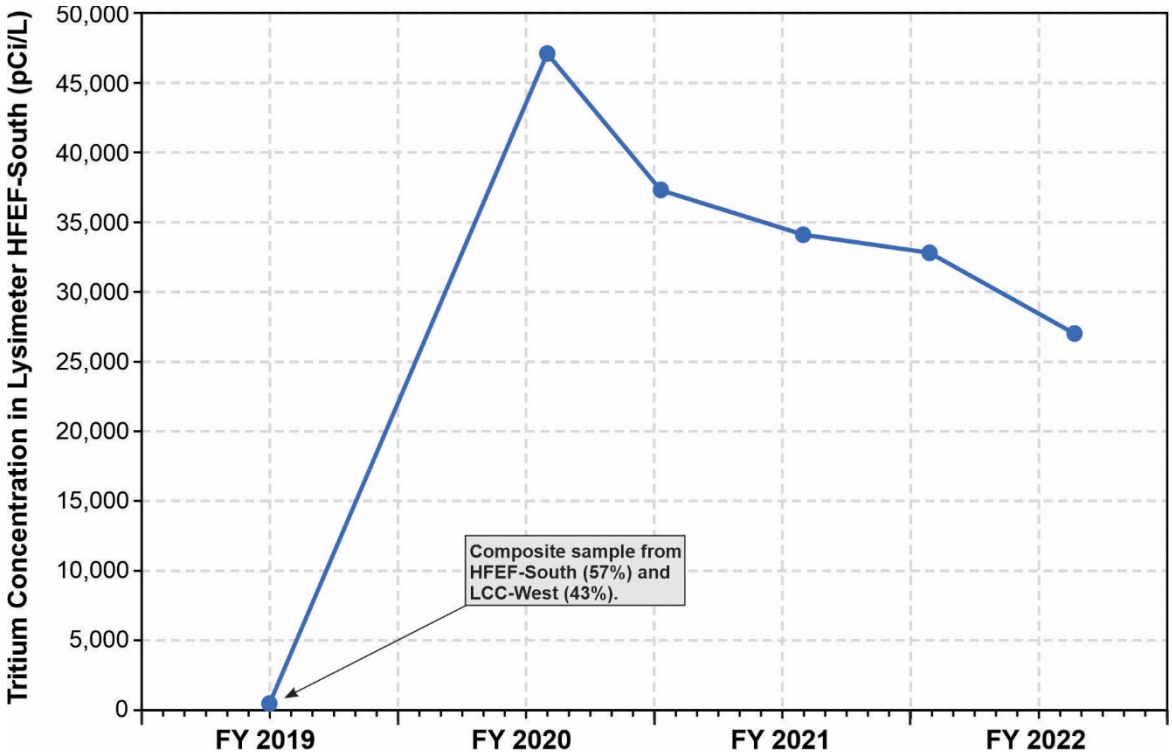

Figure 6. Tritium concentration time history in lysimeter HFEF-South.

Table 9. Compliance monitoring summary for the RHLLW Disposal Facility in FY 2022.

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 (gross alpha, gross beta, and target analytes C-14, H-3, I-129 and Tc-99)	H-3 was detected in all three aquifer wells. Gross beta was positively detected in all three wells, while 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)	Aquifer Maximum Contaminant Levels	No actions taken. Routine sampling is scheduled annually, but semi-annual sampling will continue as long as performance-monitoring action levels exceed action levels in the monitoring plan (PLN-5501), or until action levels are modified after baseline concentrations are established (see Section 5.2).	None. No impacts to the PA or CA.

CA = composite analysis
IDAPA = Idaho Administrative Procedures Act
PA = performance assessment

Table 10. Performance-monitoring summary for the RHLLW Disposal Facility in FY 2022.

Monitoring Location	Monitoring Purpose	Monitoring Results and Trends	PA Expected Behavior	Action Taken	PA/CA Impacts
Vadose zone lysimeters adjacent to and below the disposal vaults. Moisture content data reviewed to determine time to sample.	Provide data to establish baseline concentrations for future performance monitoring. Period to establish baseline is 3 years (2019–2021) but was extended through 2022 based on insufficient data. Provide data to indicate potential radionuclide release from source zone and migration toward aquifer.	All 21 of the lysimeters yielded water, and six yielded sufficient water for the full suite of analytes. All sample concentrations were non-detects or less than action levels with two exceptions. The gross alpha results for the PA-North lysimeter sample and the combined sample from the deep-alluvium lysimeters were 11.1 pCi/L and 17.9 pCi/L respectively. These are greater than the action level of 10 pCi/L. The HFEF-South lysimeter sample results for H-3 [32,800 pCi/L (fall 2021), 27,000 pCi/L (spring 2022)] exceed the drinking water MCL of 20,000 pCi/L but concentrations continue to decrease from the high value in spring 2020 (47,100 pCi/L). MCLs do not apply to porewater and are not action levels, but are used for comparison purposes only.	FY 2022 is the fourth year of operations. Because very little waste has been emplaced and only in one location (see Table 4), the concentrations are considered not to have been impacted by disposals. Therefore, these 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 2022) and monitoring results are consistent with assumptions and results from the PA.	Continue with annual spring sampling and analyze for both indicator and target analytes. Continue semi-annual sampling of selected lysimeters in the fall and analyze for tritium (first priority) and other indicator or target analytes as deemed necessary for establishing baseline concentrations as extra sample is available. Data collected through fall FY 2022 will be used to establish baseline concentrations and any changes to the monitoring schedule or monitoring plan will be determined based on the results.	None. No changes 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 2022 (see Table 11).

Table 11. Research and development activities.

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

7. PLANNED OR CONTEMPLATED CHANGES

Planned or contemplated changes are presented in Table 12. Potential changes to technical-basis documents include a revision of the WAC (PLN-5446), the monitoring plan (PLN-5501) and FRM-2544. Work that would form the basis for a special analysis was initiated in FY 2022 to address a request by NRF Waste Programs for a permanent exception to limits of removable surface contamination on the exterior of waste canisters shipped to the RHLLW Disposal Facility as specified in the WAC (see Section 2.1). This will be evaluated in UDQE-RHLLW-063. If a special analysis is required, it will be completed in FY 2023 prior to certification of NRF. If the special analysis is performed and approved, a WAC revision would be required, and FRM-2544 would be revised to update the limits for removable surface contamination for NRF waste canisters. FRM-2544 will also be revised to add NRF as a certified waste generator after the certification is complete.

It is expected the monitoring plan will be changed in FY 2023 to revise the action level for gross alpha in lysimeter samples. Action levels in the original monitoring plan were established prior to monitoring. The initial gross-alpha and gross-beta action levels were not based on regional data, modeling or protectiveness, but were established as conservative values that were less than the gross-alpha drinking water standard or the gross-beta screening level for sensitive drinking water systems based on the Environmental Protection Agency (EPA) Radionuclides Rule 66 FR 76708 (EPA 2000). Sample data collected since commencement of operations shows the initial gross-alpha action level (10 pCi/L) was exceeded in multiple lysimeter samples. Lysimeter concentration data collected during the first 4 years of operations will be used to establish baseline concentrations for indicator and target analytes in FY 2023. Given that gross alpha concentrations in some samples are above the action level and the levels are not related to operations, it may be prudent to raise the action level to avoid triggering unnecessary semi-annual sampling of lysimeters and groundwater, and speciation of lysimeter samples. Any changes to action levels will be evaluated and justified to ensure they support the monitoring plan.

Changes to monitoring are expected to continue in FY 2023. This includes semi-annual sampling of groundwater wells that began in FY 2022. This was done because the gross alpha concentration in some lysimeters exceeded the initial action level. Although these action levels only truly apply after baseline concentrations have been established, semi-annual sampling of groundwater was initiated as a precaution. This is expected to continue in FY 2023 until performance-monitoring baseline concentrations are established and action levels are reevaluated. Semi-annual sampling of selected lysimeters that began in the fall of 2020 in response to an unexpectedly high tritium concentration in lysimeter HFEF-South in the spring of 2020 will also continue in FY 2023. This issue is discussed in detail in the FY 2021 ASR (INL 2022). In addition, data from all lysimeters collected during the 3-year baseline period (FY 2019 through FY 2021) and extended to FY 2022 will be evaluated in FY 2023. This evaluation will be documented in a report with recommendations to either extend the baseline period or move to the next phase (see Section 5).

A reevaluation of the radionuclide inventory in legacy and new-generation waste in HFEF-5 waste canisters from MFC that began in FY 2022 is expected to be completed in FY 2023. This activity was initiated in response to discrepancies between canister inventories used for the PA, and updated canister inventories estimated prior to shipping to the RHLLW Disposal Facility. The updated inventory estimates are based on dose rate measurements taken prior to shipping. These discrepancies are discussed in several recently completed UDQEs (UDQE-RHLLW-053, UDQE-RHLLW-060, UDQE-RHLLW-061, UDQE-RHLLW-062 and UDQE-RHLLW-064, see Section 2.1). The results of this evaluation have the potential to impact the PA. The potential impacts will be evaluated using the change control process.

Operational activities associated with shipment and disposal of 55-ton waste canisters from NRF are expected to begin in FY 2023. An initial waste generator certification assessment for NRF began in FY 2022 and is expected to be completed in FY 2023. An initial waste generator certification of ATR Complex Waste Programs is expected to begin in FY 2023. Although these are anticipated activities and should not be considered changes, they will increase operations at the facility.

None of the planned changes discussed in the section are expected to impact the PA, CA, ODAS, or the RHLLW Disposal Facility design, operations, closure, research and development, or land use.

Table 12. Planned or contemplated changes for the RHLLW Disposal Facility.

Planned or Contemplated Change	Change Basis	PA/CA Impact	Schedule
Revise waste acceptance criteria (PLN-5446)	If UDQE-RHLLW-063 is positive and a special analysis is performed and approved, update the WAC to include revised limits for removable surface contamination for NRF waste canisters.	TBD based on results of UDQE and special analysis.	FY 2023
Establish baseline conditions for monitoring and revise monitoring plan (PLN-5501)	Establish performance-monitoring baseline concentrations based on lysimeter sampling and update action levels if necessary. Continue semi-annual sampling of selected lysimeters in response to higher-than-expected tritium levels in lysimeter HFEF-South, and semi-annual sampling of groundwater wells in response to an exceedance of initial action levels for gross alpha in some lysimeters. Continue semi-annual sampling until baseline concentrations are established and action levels are reevaluated.	None	FY 2023
Revise RHLLW Waste Canister Acceptance Sheet (FRM-2544)	If UDQE-RHLLW-063 is positive and a special analysis is performed and approved, update the limits for removable surface contamination for NRF waste canisters and add NRF as a certified waste generator after the certification is complete.	None	FY 2023
Complete evaluation of radionuclide inventories used in the PA 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 have the potential to impact the PA. The potential impacts will be evaluated using the change control process.	TBD	FY 2023
Begin operational activities and waste shipments/disposals of NRF 55-ton waste canisters	Initial waste generator certification of NRF as a generator of 55-ton waste canisters containing activated metals and SC debris began in FY 2022 and is expected to be completed in FY 2023. Operational activities and 55-ton waste canister shipments from NRF are expected to begin in FY 2023.	None	FY 2023
Begin ATR Complex waste generator certification	Initial waste generator certification of ATR Complex as a generator of ATR-5 waste canisters containing activated metals is expected to begin in FY 2023.	None	FY 2023

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 DOE Low-Level Waste Disposal Facility Federal Review Group (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 2022.

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 13).

Table 13. Example of 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 & Date Completed	PA, CA, ODAS Impact
N/A[a]						

a. Not applicable for FY 2022.

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 2022 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 consistent with assumptions of the PA and CA (Section 4).
- Compliance and performance-monitoring results indicate assumptions and conclusions of the PA and CA are appropriate (Section 5).
- One modification to a technical-basis document (change-control process document RH-ADM-5214, formerly SD-52.1.4) was completed FY 2022 (Section 7). The changes were not significant and do not challenge the continued validity of the RWMB. Projected disposal operations indicate continued compliance with the RWMB (Section 2). The most recent RWMB was submitted to DOE for review and approved by the Field Element Manager on December 11, 2020 (FY 2021). The next RWMB review is scheduled for FY 2023.

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Appendix A

Fiscal Year 2022 Unreviewed Disposal Question Screenings and Evaluations for the RHLLW Disposal Facility

Appendix A

Fiscal Year 2022 Unreviewed Disposal Question Screenings and Evaluations for the RHLLW Disposal Facility

This appendix includes copies of UDQSs and UDQEs that were completed and approved by the end of FY 2022. Evaluations that were initiated but not completed are listed as "in progress" in Table 2 of the ASR are not included here. Evaluations that were cancelled are also not included here. No special analyses were completed in FY 2022. The following are included herein:

- RHLLW-UDQE-049, Page 48
- RHLLW-UDQE-050, Page 55
- RHLLW-UDQE-051, Page 62
- RHLLW-UDQE-052, Page 67
- RHLLW-UDQE-053, Page 82
- RHLLW-UDQE-054, Page 99
- RHLLW-UDQE-056, Page 105
- RHLLW-UDQE-059, Page 111
- RHLLW-UDQE-060, Page 119
- RHLLW-UDQE-061, Page 134
- RHLLW-UDQE-062, Page 156
- RHLLW-UDQE-064, Page 178.

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

UDQE Tracking No.: UDQE-RHLLW-049

Subject: 2021 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 2021 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.

This UDQE is being prepared and evaluated because the annual inspection (WO 307956) identified a new Level 3 defect on the HFEF CVAS as follows:

- The HFEF CVAS exhibited a defect as identified on the attached FRM-2539. This crack is >0.01 inches in width over 11.5 inches in length from the top edge down the face nearest the vault access port. The crack depth was indeterminant.

This defect is being evaluated in this UDQE to ensure it is acceptable for use and is 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	1/12/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Tim Arsenault	1/12/2022
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 307956 (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 one Level 3 damaged area on the HFEF CVAS as noted in the description section of this UDQE. The attached inspection form (FRM-2539) contains a photograph and measurement details of the damaged area for evaluation.

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. However, as required by SDD-410, the damages will be repaired using approved repair materials (see SPC-1910; Jet Set Smooth) 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 2021-0145 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 will be made by using model routine repair WO 2581120 and MWR 2021-4146 and be performed by trained personnel. Once the repairs are made, they will be re-inspected by the qualified inspector and documented in the repair work order.

Jonathan Jacobson	Jonathan Jacobson	9/28/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	9/28/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	09/28/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Amy M. Cox	Amy M. Cox	2022.09.29
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	9/29/2022
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-050

Subject: UDQE-RHLLW-050, Vault Shield Plugs Exhibiting Level 3 or Greater Damage - 2021 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 2021 annual inspection (WO 310808) identified new Level 3 defects on the vault shield (VSPs) currently installed in Array 2 at position E2, (VSP-PLG-HF-P14); D2 (VLT-PLG-HF-P11); and the South PA (VLT-PLG-PA-P02). These issues were identified in PM WO 310808 during annual preventive maintenance inspections.

- The VSP currently installed in the Array 2, E2 position exhibited a chip at the top southeast corner that is approximately 2-1/4" X 3-1/2" and approximately 1" in depth.
- The four cracks in VSP D2 range from 3-1/2" to 7-1/2" in length, >0.01" in width, and an approximate maximum depth of ½" and are located on various locations on the top surface.
- Three cracks in the South PA vault VSP range from 4" to 6" in length, >0.01" in width, and an approximate maximum depth of 1", and are located on various locations on the top surface.

These defects are being evaluated in this UDQE and 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	1/12/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Tim Arsenault	1/12/2022
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 VSP currently installed in the Array 2, E2 position exhibited a chip at the top southeast corner that is approximately 2-1/4" X 3-1/2" and approximately 1" in depth. 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 will be 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 repairs will be made by trained personnel as required by SDD-410 and per manufacturer's recommendations. Once the repairs are made, they will be re-inspected by the qualified inspector and documented as required by SDD-410. After repair, the area is expected to provide protection against water ingress into the steel reinforcement material and to result in no impact to long-term vault performance.

The four cracks in VSP D2 range from 3-1/2" to 7-1/2" in length, >0.01" in width, and an approximate maximum depth of ½" and are located on various locations on the top surface. The cracks 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 evaluated in INL/EXT-17-42239. As required by SDD-410, the cracks will be 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.

Three cracks in the South PA vault VSP range from 4" to 6" in length, >0.01" in width, and an approximate maximum depth of 1" and are located on various locations on the top surface. The cracks 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 evaluated in INL/EXT-17-42239. As required by SDD-410, the cracks will be 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 three VSPs, an operability review was completed to ensure the characteristics important to the safety analysis have not been degraded. This review documented in OPR 2021-0163 determined that each of the three VSPs are operable and not degraded. Maintenance Work Request MWR-2021-4669 was submitted to initiate repairs of each issue as identified above. Following repairs, each VSP will be re-inspected to ensure repairs are acceptable and to ensure there is no impact to long-term vault performance.

Jonthan Jacobson	Jonathan Jacobson	9/28/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	9/28/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	09/28/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Amy M. Cox	Amy M. Cox	2022.09.29
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	9/29/2022
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-051

Subject: NSFH waste canister design change for the bolt material from Nitronic 60 to ASTM A453 Grade 660 stainless steel

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:

The NRF canister design team has been working on the Naval Spent Fuel Handling (NSFH) waste canister. The canister design team is requesting a change in lid bolt material from Nitronic 60 (annealed) to ASTM A453 Grade 660 stainless steel. The Nitronic 60 material was previously evaluated and approved for use and documented in UDQE-RHLLW-014. The Nitronic 60 is an austenitic stainless-steel alloy with the general corrosion resistance between Type 304 and Type 316L stainless steel. The canister design team has requested approval for the use of similar material made up of ASTM A453 Grade 660 stainless steel (Alloy A286). Similar to Nitronic 60, ASTM A453 Grade 660 stainless steel is an austenitic stainless steel with corrosion resistance beyond 304 SS and comparable to 316L SS and the electrode potential (passive) is essentially the same as Type 316L stainless steel. Additionally, external hardware such as bolts, washers, alignment pins, hoist rings and drain valve components is acceptable for the NSHF canister as long as the NSHF outer canister is constructed of Type 316L stainless steel.

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?*

Comments: Yes ☐ No ☒

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).*

Comments: Yes ☐ No ☒

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?*

Comments: Yes ☐ No ☒

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?*

Comments: Yes ☐ No ☒

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

Comments: Yes ☐ No ☒

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)?*

Comments: Yes ☐ No ☒

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)?*

Comments: Yes ☐ No ☒

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)?*

Comments: Yes ☐ No ☒

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

Comments: Yes ☐ No ☒

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: The use of ASTM A453 Grade 660 stainless steel bolts, washers or alignment pins is acceptable because they do not penetrate the canister outer boundary and therefore, do not violate WAC requirements. Additionally, similar to the use of Nitronic 60 bolts evaluated in UDQE-RHLLW-014, the corrosion resistance of ASTM A453 Grade 660 is comparable to Type 316L stainless steel and it has a low galvanic (bimetallic) corrosion potential in the presence of Type 361L stainless steel. Based on this, the use of ASTM A453 Grade 660 stainless-steel bolts is not expected to violate the assumptions and conclusions of the PA.

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	10/11/2021
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Tim Arsenault	10/11/2021
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)?*

Comments: Yes ☐ No ☐

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

Comments: Yes ☐ No ☐

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

Comments: Yes ☐ No ☐

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

Comments: Yes ☐ No ☐

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

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

UDQE Tracking No.: UDQE-RHLLW-052

Subject: Disposal of surface contaminated debris with NRFs waste streams (activated metals and resins).

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:

The RHLLW Disposal Facility has been designed and constructed to support 20 years disposal capability with potential expansion capacity to support up to 50 years of waste disposals. ECAR-3940 "*Baseline Radionuclide Inventory for the Remote Handled Low-Level Waste Disposal facility for Use in the Facility Performance Assessment*" documents 20 and 50-years of baseline radionuclide inventory anticipated for disposal in the RHLLW Disposal Facility.

Naval Reactors Facility (NRF) provided projected radioactivity estimates for 50 years of waste shipments to the RHLLW Disposal Facility (NRF 2011) for preparation of the PA (DOE-ID 2018). This information is included in ECAR-3940. The NRF waste streams includes non-fuel bearing activated metal structurals (activated metals) and ion-exchange resins. The activated metal waste stream includes both activation and fission products integral to the metal, along with other radionuclides on the surfaces of the metal components (referred to as "crud"). As indicated in PLN-5446 "*Waste Acceptance Criteria for the Remote-handled Low-Level Waste Disposal Facility*" per footnote (a) NRF waste canisters of activated metals may contain small amounts of surface-contaminated debris. The activated metal structural components will make up 75-85% of the volume while surface contaminated debris will make up 10-15% of the volume. The NRF activated metal waste is approximately 98% Inconel or Zircaloy and approximately 2% stainless steel. The surface contaminated debris is referred to as water pool debris loaded in water pool skimmer baskets and consists of nylon lanyards, steel water pool hooks, nylon rigging straps, etc.

The estimated surface contaminated debris activity contribution was not included in the Holden letter provided by NRF in 2011 (NRF 2011) and therefore, not included in the PA. Technical Work Record (TWR)-21794 (see below) was supplied in 2021 by NRF Waste Programs documenting the projected average case activity of surface contaminated debris in a 55-Ton waste canister. The result indicated that activities of 15 radionuclides from the surface contaminated debris meet the minimum reporting limits established in Table A-13, Appendix A of PLN-5546. Two of the 15 radionuclides (Eu-152 and H-3) were not in the original list of "crud" radionuclides analyzed in the RHLLW Disposal Facility PA and not listed in Appendix B, table B-6 of PLN-5546.

Because the projected inventory of NRF surface contaminated debris documented in TWR-21794 supplied by NRF Waste Programs was not included in the PA base case inventory (ECAR-3940), it must be evaluated to determine if it is within the bounds of the approved PA.

TECHNICAL WORK RECORD

FORM 74035H

TWR BOOK No. 21794

PAGE 51

KEYWORD SUBJECT

Water Pool Debris Contribution to RH-LLW Activity (Supplement)

Although a maximum theoretical surface contamination estimate would be considered inconsequential in terms of maximum activity limits in a 55 Ton waste canister (Pages 49-50C of this TWR), consideration must also be given to the minimum reporting limits established in the Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility, PLN-5446, Appendix A, Table A-13. The following provides an evaluation related to an AVERAGE water pool debris (nylon lanyards, steel water pool hooks, nylon rigging straps, skimmer bags, etc.) radioactivity content in NRF Remote Handled Low Level Waste (RH-LLW) canisters.

Basis/Assumptions

The following basis and assumptions apply to this evaluation:

- Non-fuel bearing activated metal structurals make up 75-85% of the volume of LLW within a canister while surface contaminated debris make up 10-15% of the volume with 5-10% void accounting for the remainder.
- Per Footnote (a) to Table A-1 of PLN-5446, "NRF activated metals canisters may contain small amounts of surface-contaminated debris." The projected 10-15% of the waste canister volume is considered a small amount, especially when considering the total radioactivity content of each canister. Activated metals will account for multiple orders of magnitude of curies, while contaminated debris will be in the millicurie range.
- An average case loading of debris will be taken conservatively as 5 skimmer bags at 10 mrem/hr.
    - Radiological surveys of various water pit debris was conducted on March 15, 2021.
        - The water pool hooks, lanyards, and nylon rigging slings surveyed were all less than 0.5 mrem/hr. This was as expected as contamination is passively deposited on such items.
        - Water pool skimmer baskets and bags were generally around 10 mrem/hr. Due to the filtration function of the skimmer assemblies, the active deposition of contamination on these items was expected. This 10 mrem/hr average is supported for active filtration deposition by an evaluation of the chiller filters currently being removed from the ECF Water Pools for **non** RHLLW disposal. Based on surveys conducted on 64 chiller filters, an average, above water, on contact radiation reading was determined to be 8.2 mrem/hr.
        - An average loading of contaminated debris will include multiple nylon slings and lanyards with a potential for zero to up to 5 skimmer bags. To account for the passive radioactivity deposition and the potential for active radioactivity deposition, the average radioactivity will be based on a 5 skimmer bag loading.
- The skimmer bag dimensions are taken from Drawing 6D28774 and is modelled in Microshield as a cylindrical surface with a 7" diameter and a 72" length. Note: As the bags are made of a felt material, the length is compacted when placed in a RH-LLW insert, thus the final waste volume envelope is significantly smaller.
- The current ECF Water Pool Isotopic distribution is utilized for the radioactivity content estimate. Note: The ECF Water Pool source term is re-evaluated (e.g. sampling performed) every 3 years. Changes to the source term will be formally documented and reflected in the average case loading of debris into canisters.
- As this is a hypothetical average loading of surface contaminated debris within a RH-LLW canister, the results will be compared to the minimum reporting limits established in the Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility, PLN-5446, Appendix A, Table A-13. This method will establish which radionuclides might be of concern based on the Table A-13 criteria.

PAGES COVERED 51 THRU 53 COGNIZANT ENGINEER 007334 DATE 9/16/2021	DEPTH OF CHECK AND RESULTS HAVE BEEN RECORDED ON PAGE(S) 53 PAGES COVERED 51 THRU 53 REVIEWER 501129 DATE 9/20/2021	PAGES COVERED 51 THRU 53 SUPERVISOR 500925 DATE 9/20/2021

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KEYWORD SUBJECT

Water Pool Debris Contribution to RH-LLW Activity (Supplement)

Calculation

As previously analyzed on Page 50A of this TWR, a Microshield modeling for a skimmer bag with a 1 Ci Co-60 deposition on the cylindrical surface results in a surface radiation level of 2.939E+04 mrem/hr. Thus, for an average case 10 mrem/hr skimmer bag, the Co-60 activity is:

$$10 \text{ mrem/hr} \times \frac{1 \text{ Ci Co-60}}{2.939\text{E+4 mrem/hr}} = 3.40\text{E-04 Ci Co-60}$$

For 5 skimmer bags, the total Co-60 activity would be 1.7E-03 Ci Co-60

Page 52A provides the ECF Waste Pool Isotopic Distribution results utilizing this 1.7E-03 Ci Co-60 as an input.

Comparison to PLN-5446, Appendix A, Table A-13

Page 52A also provides a comparison of this average case surface contaminated debris isotopic activity to those radionuclides with minimum reporting level established in Table A-13.

The resultant comparison indicates that 14 of the 15 reportable radionuclides are considered, by Footnote b to Table A-13, to require mandatory reporting (or a 1.00E-12 Ci reporting limit). The other reportable radionuclide, Eu-152, is reportable as it exceeds 0.1% of the lowest maximum canister waste limit. For reference, the average contaminated debris Eu-152 activity of 5.29E-04 Ci is 0.286% of the 1.85E-01 Ci lowest maximum canister waste limit; reportable, but less than 1% of the stated limit.

Conclusion

As shown in the spreadsheet on Page 52A, there are 15 reportable radionuclides associated with an average case surface contaminated debris within each NRF waste canister when compared to the minimum reporting limits established in Table A-13.

Activity Reporting for Each Canister

To meet the minimum reporting limits established in Table A-13, NRF Waste Programs will sum the surface contamination contribution on all the activated metal structural within an individual canister **AND** add the entire radionuclide listing (see Page 52A) for the average case surface contaminated debris identified in this evaluation. This total surface contamination contribution will be compared to the minimum reporting levels established in Table A-13 and those reportable radionuclides will be submitted to RDF as part of each individual canister shipment profile. NRF Waste Programs will report the contribution of surface contamination on the activated metal structurals within each canister added to the above calculated average contaminated debris as a separate supplemental document. This separate supplemental document will be incorporated into the full documentation for the activity estimate for each canister.

The use of the average case surface contaminated debris identified in this evaluation is intended to preclude the need to perform underwater surveys on each and every surface contaminated debris item placed in an NRF waste canister. This is intended to increase water pool operational efficiency but also appropriately account for radioactivity associated with such debris. Each NRF waste canister inventory will be reviewed by NRF Waste Programs to ensure the average case adequately represents the surface contaminated debris within the individual canister. Adjustment (increase) may be necessary to account for unique surface contaminated debris items identified for disposal in an individual RH-LLW canister. Radiological surveys will be conducted on such unique surface contaminated debris items.

The total activity (activation activity plus surface contamination activity) for each canister shipment profile will also be compared to the Table A-13 minimum reporting limits and those reportable radionuclides will be entered into the Intergrated Waste Tracking System (IWTS) canister shipment profile. Additionally, the canister radioactivity content will be entered into the other RDF WAC required databases and forms as required.

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PAGE **53**

KEYWORD SUBJECT

Water Pool Debris Contribution to RH-LLW Activity (Supplement)

Depth of Check

- Verified data on activated metal structure volume percent and surface contaminated percent volume.
- Verified calculation of Chiller Filter average radiation level.
- Verified total calculation Co-60 activity for 5 skimmer bags.
- Verified activity (Ci) calculations on spread sheet.
- Concur with conclusions regarding 15 reportable radionuclides.
- Concur with Eu-152 reporting analysis.
- Concur with methodology on activity reporting for each canister.

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TWR 21794 Pg 52A

WATER PIT ISOTOPIC DISTRIBUTION
Rev 3 February 2019

Average Contaminated Debris
Co-60 Ci 1.70E-03 2.27E+06 g 2.62E+00 m^3

	$T_{1/2}$ days	Co-60 Ratios	Activity Ci	Activity TBq	A_2 TBq	Activity/A_2	% Total Activity / A2	% Total Activity	Ci/m^3	nCi/g	Watts / Ci	RDF WAC Min Level		Ratio	Reportable
Am-241	1.58E+05	3.06E-05	5.20E-08	1.92E-09	1.0E-03	1.92E-06	0.75%	0.00%	1.98E-08	2.29E-05	3.34E-02	1.00E-01	nCi/gm	2.29E-04	
C-14	2.09E+06	8.54E-02	1.45E-04	5.37E-06	3.0E+00	1.79E-06	0.70%	3.00%	5.54E-05	6.40E-02	2.93E-04	1.00E-12	Ci	1.45E+08	X
Cm-243	1.06E+04	5.80E-06	9.86E-09	3.65E-10	1.0E-03	3.65E-07	0.14%	0.00%	3.76E-09	4.35E-06	3.68E-02	1.00E-01	nCi/gm	4.35E-05	
Cm-244	6.61E+03	8.89E-06	1.51E-08	5.59E-10	2.0E-03	2.80E-07	0.11%	0.00%	5.77E-09	6.66E-06	3.50E-02	5.95E-08	Ci	2.54E-01	
Cm-245	3.10E+06	9.46E-07	1.61E-09	5.95E-11	9.0E-04	6.61E-08	0.03%	0.00%	6.14E-10	7.09E-07	3.33E-02	1.00E-01	nCi/gm	7.09E-06	
Co-58	7.09E+01	2.37E-03	4.04E-06	1.49E-07	1.0E+00	1.49E-07	0.06%	0.08%	1.54E-06	1.78E-03	5.99E-03	5.63E-04	Ci	7.17E-03	
Co-60	1.93E+03	1.00E+00	1.70E-03	6.29E-05	4.0E-01	1.57E-04	61.52%	35.12%	6.49E-04	7.50E-01	1.54E-02	1.00E-12	Ci	1.70E+09	X
Cr-51	2.77E+01	5.32E-03	9.05E-06	3.35E-07	3.0E+01	1.12E-08	0.00%	0.19%	3.45E-06	3.99E-03	2.17E-04	1.02E-01	Ci	8.87E-05	
Cs-134	7.54E+02	2.60E-05	4.41E-08	1.63E-09	7.0E-01	2.33E-09	0.00%	0.00%	1.68E-08	1.95E-05	1.02E-02	6.49E-05	Ci	6.80E-04	
Cs-137	1.10E+04	1.27E-02	2.16E-05	8.01E-07	6.0E-01	1.33E-06	0.52%	0.45%	8.26E-06	9.54E-03	1.11E-03	1.00E-12	Ci	2.16E+07	X
Eu-152	4.95E+03	3.11E-01	5.29E-04	1.96E-05	1.0E+00	1.96E-05	7.66%	10.93%	2.02E-04	2.33E-01	7.67E-03	1.85E-04	Ci	2.86E+00	X
Eu-154	3.14E+03	3.77E-02	6.41E-05	2.37E-06	6.0E-01	3.95E-06	1.55%	1.32%	2.44E-05	2.83E-02	9.01E-03	1.75E-04	Ci	3.66E-01	
Eu-155	1.73E+03	3.84E-03	6.53E-06	2.42E-07	3.0E+00	8.05E-08	0.03%	0.13%	2.49E-06	2.88E-03	7.75E-04	N/A			
Fe-55	1.00E+03	5.30E-01	9.02E-04	3.34E-05	4.0E+01	8.34E-07	0.33%	18.63%	3.44E-04	3.98E-01	3.49E-05	1.35E-01	Ci	6.68E-03	
Fe-59	4.45E+01	1.61E-03	2.74E-06	1.01E-07	9.0E-01	1.13E-07	0.04%	0.06%	1.04E-06	1.21E-03	7.75E-03	7.98E-03	Ci	3.43E-04	
H-3	4.50E+03	9.30E-04	1.58E-06	5.85E-08	4.0E+01	1.46E-09	0.00%	0.03%	6.03E-07	6.97E-04	3.38E-05	1.00E-12	Ci	1.58E+06	X
Hf-175	7.00E+01	9.70E-03	1.65E-05	6.10E-07	3.0E+00	2.03E-07	0.08%	0.34%	6.29E-06	7.27E-03	2.42E-03	N/A			
Hf-181	4.24E+01	4.31E-02	7.32E-05	2.71E-06	5.0E-01	5.42E-06	2.12%	1.51%	2.79E-05	3.23E-02	4.36E-03	5.43E-04	Ci	1.35E-01	
I-129	5.73E+09	1.49E-07	2.53E-10	9.37E-12	Unlimited	0.00E+00	0.00%	0.00%	9.66E-11	1.12E-07	4.63E-04	1.00E-12	Ci	2.53E+02	X
Mn-54	3.12E+02	1.22E-02	2.08E-05	7.69E-07	1.0E+00	7.69E-07	0.30%	0.43%	7.93E-06	9.17E-03	4.98E-03	7.03E-03	Ci	2.96E-03	
Nb-93m	5.88E+03	3.63E-02	6.18E-05	2.29E-06	3.0E+01	7.62E-08	0.03%	1.28%	2.36E-05	2.72E-02	1.83E-04	3.63E-02	Ci	1.70E-03	
Nb-94	7.31E+06	1.00E-03	1.70E-06	6.29E-08	7.0E-01	8.99E-08	0.04%	0.04%	6.49E-07	7.50E-04	1.03E-02	1.00E-12	Ci	1.70E+06	X
Nb-95	3.50E+01	5.02E-03	8.53E-06	3.16E-07	1.0E+00	3.16E-07	0.12%	0.18%	3.26E-06	3.76E-03	4.80E-03	2.02E-03	Ci	4.22E-03	
Ni-59	2.78E+07	1.12E-02	1.90E-05	7.03E-07	Unlimited	0.00E+00	0.00%	0.39%	7.25E-06	8.38E-03	4.25E-05	1.00E-12	Ci	1.90E+07	X
Ni-63	3.69E+04	4.35E-01	7.40E-04	2.74E-05	3.0E+01	9.12E-07	0.36%	15.28%	2.82E-04	3.26E-01	1.02E-04	1.00E-12	Ci	7.40E+08	X
Pu-238	3.20E+04	5.99E-04	1.02E-06	3.77E-08	1.0E-03	3.77E-05	14.74%	0.02%	3.88E-07	4.49E-04	3.32E-02	1.00E-01	nCi/gm	4.49E-03	
Pu-239	8.80E+06	8.36E-06	1.42E-08	5.26E-10	1.0E-03	5.26E-07	0.21%	0.00%	5.42E-09	6.26E-06	3.11E-02	1.00E-12	Ci	1.42E+04	X
Pu-240	2.40E+06	9.42E-07	1.60E-09	5.92E-11	1.0E-03	5.92E-08	0.02%	0.00%	6.11E-10	7.06E-07	3.12E-02	1.00E-12	Ci	1.60E+03	X
Pu-241	5.22E+03	6.34E-04	1.08E-06	3.99E-08	6.0E-02	6.65E-07	0.26%	0.02%	4.11E-07	4.75E-04	3.18E-05	4.20E-06	Ci	2.57E-01	
Ru-103	3.93E+01	2.25E-03	3.83E-06	1.42E-07	2.0E+00	7.09E-08	0.03%	0.08%	1.46E-06	1.69E-03	3.34E-03	N/A			
Sb-125	1.01E+03	2.09E-01	3.54E-04	1.31E-05	1.0E+00	1.31E-05	5.13%	7.32%	1.35E-04	1.56E-01	3.15E-03	1.18E-03	Ci	3.00E-01	
Sn-113	1.15E+02	8.00E-03	1.36E-05	5.03E-07	2.0E+00	2.52E-07	0.10%	0.28%	5.19E-06	6.00E-03	1.75E-04	3.25E-02	Ci	4.18E-04	
Sr-90	1.05E+04	1.36E-02	2.31E-05	8.53E-07	3.0E-01	2.84E-06	1.11%	0.48%	8.79E-06	1.02E-02	1.16E-03	1.00E-12	Ci	2.31E+07	X
Ta-182	1.14E+02	5.47E-03	9.29E-06	3.44E-07	5.0E-01	6.88E-07	0.27%	0.19%	3.55E-06	4.10E-03	8.89E-03	1.24E-04	Ci	7.49E-02	
Tc-99	7.78E+07	1.54E-03	2.61E-06	9.66E-08	9.0E-01	1.07E-07	0.04%	0.05%	9.96E-07	1.15E-03	5.99E-04	1.00E-12	Ci	2.61E+06	X
Te-125m	5.80E+01	4.82E-02	8.19E-05	3.03E-06	9.0E-01	3.37E-06	1.32%	1.69%	3.12E-05	3.61E-02	8.58E-04	7.78E-04	Ci	1.05E-01	
U-233	5.81E+07	7.20E-06	1.22E-08	4.53E-10	6.0E-03	7.55E-08	0.03%	0.00%	4.67E-09	5.40E-06	2.91E-02	N/A			
U-234	8.99E+07	7.20E-06	1.22E-08	4.53E-10	6.0E-03	7.55E-08	0.03%	0.00%	4.67E-09	5.40E-06	2.88E-02	1.00E-12	Ci	1.22E+04	X
U-235	2.57E+11	3.41E-06	5.79E-09	2.14E-10	Unlimited	0.00E+00	0.00%	0.00%	2.21E-09	2.55E-06	2.77E-02	1.00E-12	Ci	5.79E+03	X
U-236	8.55E+09	3.41E-06	5.79E-09	2.14E-10	6.0E-03	3.57E-08	0.01%	0.00%	2.21E-09	2.55E-06	2.71E-02	N/A			
Zn-65	2.44E+02	1.07E-02	1.83E-05	6.76E-07	2.0E+00	3.38E-07	0.13%	0.38%	6.97E-06	8.05E-03	3.49E-03	8.48E-03	Ci	2.15E-03	
Zr-95	6.40E+01	2.34E-03	3.98E-06	1.47E-07	8.0E-01	1.84E-07	0.07%	0.08%	1.52E-06	1.76E-03	5.03E-03	1.23E-03	Ci	3.24E-03	
Total			**4.84E-03**	1.79E-04		2.56E-04									

Total TRU 4.84E-04 nCi/g Mixture A_2 7.01E-01 TBq Decay Heat Watts: 3.30E-05

Shipment Classification

Limited Quantity — Meets Limited Quantity if total activity is less than 0.001 times mixture A_2.
2.56E-01 Meets Limited Quantity activity criteria

LSA-I — Meets LSA-I criteria if total sum of fractions for Exempt Mat'l Activity Concentration divided by 30 is less than 1.
1.37E-01 Meets LSA-I activity criteria (if applicable)

LSA-II — Meets LSA-II criteria if total activity divided by total weight is less than 0.0001 times mixture A_2/g.
1.13E-06 Meets LSA-II activity criteria (if applicable)

Water pit isotopic distribution documented in TWR 19921 pg 41.
Spreadsheet verified by hand calculations TWR 20969 pg 59.
U and TRU nuclides added per TWR 20969 pg 59.
Spreadsheet revision to meet new DOT requirements documented in TWR 22138 pg 60.
Verification of fissile material, limited quantity, LSA-I, and LSA-II calculations documented in TWR 22138 pg 87.
Workbook verification documented in NRF-E(WE)-277.
Waste Classification worksheet addition documented in TWR Z02767 pg 8.
Revision 2 documented in TWR 21492 pg 17. Minor edits and addition of RWMC WAC spreadsheet.
Revision 3 documented in TWR Z03074 pg 50 to update nuclide distribution per TWR Z03074 pgs 43-44.

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: The projected average case inventory of NRF surface contaminated debris documented in TWR-21794 supplied by NRF Waste Programs was not evaluated in the facility PA. This change must be evaluated per RH-ADM-5214 to determine if it is within the bounds of the approved PA.

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	8/18/22
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	8/18/22
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:

To determine if the surface contamination on NRF debris is within the bounds of the PA, an average case isotopic activity for NRF surface contaminated debris was compared to the total surface contamination from all generators considered in the PA. Both are released in the same manner from the source zone in the PA model. If the ratio of surface contamination on debris to the total surface contamination from all generators considered in the PA is small (< 10%) for each radionuclide, then the surface contamination on debris can be considered within the bounds of the PA and a relatively small addition compared to the PA base case inventory.

Table 1 contains a summary of the average case isotopic activities for NRF surface contaminated debris. Column 3 contains the activities for one 55-Ton waste canister according to TWR-21794. The activities in one NSFH canister (a.k.a LCC) (Column 4) were determined by multiplying the activity in a 55-Ton canister by the ratio of the canister volumes. The volume of an NSFH canister is $7.8m^3$ and the volume of a 55-Ton canister is $2.5m^3$. Therefore, Column 4 = Column 3 x ($7.8m^3/2.5m^3$). The RHLLW disposal facility has space for 168 55-Ton canisters and 195 NSFH canisters. NRF personnel have estimated the percentage of canisters that contain resins is between 6% and 10% (Email from Jack Stepan to Jon Jacobson, 4/21/2022). For this evaluation the percentage of resin cans was assigned 8% meaning the percentage of activated metal canisters with debris is 92%. This results in 155 55-Ton canisters (168 x 0.92) and 179 NSFH canisters (196 x 0.92) of activated metal and debris at capacity. Therefore, the total average case debris activity in all 55-Ton canisters (Column 5) is Column 3 x 155 and the total average case activity in all NSFH canisters (Column 6) is Column 4 x 179. The 20-year total activity for both 55-Ton and NSFH canisters (Column 7) is the sum of Columns 5 and 6.

Table 1. Summary of average case isotopic activities for NRF surface contaminated debris.

1	2	3	4	5	6	7
Nuclide	Half-life (yrs)	Debris activity in 1 55-Ton canister (Ci)	Debris activity in 1 NSFH canister (Ci)	Debris activity in 155 55-Ton canisters (Ci)	Debris activity in 179 NSFH canisters (Ci)	Total 20-yr NRF debris activity as SC (Ci)
Am-241	432.2	5.20E-08	1.62E-07	8.06E-06	2.90E-05	3.71E-05
C-14[a]	5700	1.45E-04	4.52E-04	2.25E-02	8.10E-02	1.03E-01
Cm-243	29.1	9.86E-09	3.08E-08	1.53E-06	5.51E-06	7.03E-06
Cm-244	18.1	1.51E-08	4.71E-08	2.34E-06	8.43E-06	1.08E-05
Cm-245	8500	1.61E-09	5.02E-09	2.50E-07	8.99E-07	1.15E-06
Co-58	5.27	4.04E-06	1.26E-05	6.26E-04	2.26E-03	2.88E-03
Co-60[a]	2.06	1.70E-03	5.30E-03	2.64E-01	9.49E-01	1.21E+00
Cr-51	30.2	9.05E-06	2.82E-05	1.40E-03	5.05E-03	6.46E-03
Cs-134	13.5	4.41E-08	1.38E-07	6.84E-06	2.46E-05	3.15E-05
Cs-137[a]	8.59	2.16E-05	6.74E-05	3.35E-03	1.21E-02	1.54E-02
Eu-152	4.76	5.29E-04	1.65E-03	8.20E-02	2.95E-01	3.77E-01
Eu-154	2.74	6.41E-05	2.00E-04	9.94E-03	3.58E-02	4.57E-02
Eu-155	12.3	6.53E-06	2.04E-05	1.01E-03	3.65E-03	4.66E-03
Fe-55	1.57E+07	9.02E-04	2.81E-03	1.40E-01	5.04E-01	6.44E-01
Fe-59	16.1	2.74E-06	8.55E-06	4.25E-04	1.53E-03	1.95E-03
H-3[a]	2.03E+04	1.58E-06	4.93E-06	2.45E-04	8.82E-04	1.13E-03
Hf-175	1.01E+05	1.65E-05	5.15E-05	2.56E-03	9.21E-03	1.18E-02
Hf-181	100.1	7.32E-05	2.28E-04	1.13E-02	4.09E-02	5.22E-02
I-129[a]	87.7	2.53E-10	7.89E-10	3.92E-08	1.41E-07	1.81E-07
Mn-54	2.41E+04	2.08E-05	6.49E-05	3.22E-03	1.16E-02	1.48E-02
Nb-93m	6564	6.18E-05	1.93E-04	9.58E-03	3.45E-02	4.41E-02
Nb-94[a]	14.35	1.70E-06	5.30E-06	2.64E-04	9.49E-04	1.21E-03
Nb-95	2.76	8.53E-06	2.66E-05	1.32E-03	4.76E-03	6.09E-03
Ni-59[a]	28.8	1.90E-05	5.93E-05	2.95E-03	1.06E-02	1.36E-02
Ni-63[a]	2.11E+05	7.40E-04	2.31E-03	1.15E-01	4.13E-01	5.28E-01

Pu-238	1.59E+05	1.02E-06	3.18E-06	1.58E-04	5.70E-04	7.28E-04
Pu-239[a]	2.46E+05	1.42E-08	4.43E-08	2.20E-06	7.93E-06	1.01E-05
Pu-240[a]	7.04E+08	1.60E-09	4.99E-09	2.48E-07	8.94E-07	1.14E-06
Pu-241	2.34E+07	1.08E-06	3.37E-06	1.67E-04	6.03E-04	7.71E-04
Ru-103	432.2	3.83E-06	1.19E-05	5.94E-04	2.14E-03	2.73E-03
Sb-125	5700	3.54E-04	1.10E-03	5.49E-02	1.98E-01	2.53E-01
Sn-113	29.1	1.36E-05	4.24E-05	2.11E-03	7.60E-03	9.70E-03
Sr-90[a]	18.1	2.31E-05	7.21E-05	3.58E-03	1.29E-02	1.65E-02
Ta-182	8500	9.29E-06	2.90E-05	1.44E-03	5.19E-03	6.63E-03
Tc-99[a]	5.27	2.61E-06	8.14E-06	4.05E-04	1.46E-03	1.86E-03
Te-125m	2.06	8.19E-05	2.56E-04	1.27E-02	4.57E-02	5.84E-02
U-233	30.2	1.22E-08	3.81E-08	1.89E-06	6.81E-06	8.70E-06
U-234[a]	13.5	1.22E-08	3.81E-08	1.89E-06	6.81E-06	8.70E-06
U-235[a]	8.59	5.79E-09	1.81E-08	8.97E-07	3.23E-06	4.13E-06
U-236	4.76	5.79E-09	1.81E-08	8.97E-07	3.23E-06	4.13E-06
Zn-65	2.74	1.83E-05	5.71E-05	2.84E-03	1.02E-02	1.31E-02
Zr-95	12.3	3.98E-06	1.24E-05	6.17E-04	2.22E-03	2.84E-03

a. Key radionuclide fully assessed in the PA. Reported limits for these radionuclides set at 1E-12 Ci (PLN-5446).

Table 2 compares the average case isotopic activity for NRF surface contaminated debris (Column 2) to the total surface contamination from all generators considered in the PA (Column 3). For this comparison, all radionuclides in Table 1 with half-lives less than 1 year were eliminated. This is consistent with the Phase I screening in the PA. The ratio of surface contamination on NRF debris to the total surface contamination from all generators considered in the PA is shown in Column 4. The ratios are very small (< 10%) for all but five radionuclides and most of the ratios are much less than 1%. Radionuclides with ratios less than 10% can be considered within the bounds of the PA and a relatively small addition compared to the PA base case inventory. For the five radionuclides with ratios greater than 10%, each will be evaluated using information from the PA.

Table 2. Comparison of NRF activity in debris to total PA activity as surface contamination.

1	2	3	4	5
Nuclide	Total 20-yr NRF debris activity as SC (Ci)	Total PA activity as SC (Ci)	Ratio NRF debris SC to total PA SC	GW Screening Phase Nuclide Eliminated
Am-241	3.71E-05	2.32E-02	0.2%	Retained
C-14	1.03E-01	8.07E+00	1%	Retained
Cm-243	7.03E-06	9.21E-05	8%	III
Cm-244	1.08E-05	4.88E-03	0.2%	III
Cm-245	1.15E-06	2.89E-07	397%[a]	II
Co-60	1.21E+00	7.34E+02	0.2%	III
Cs-134	3.15E-05	1.27E-01	0.02%	III
Cs-137	1.54E-02	9.18E+02	0.002%	III
Eu-152	3.77E-01	0	Infinite[a]	III
Eu-154	4.57E-02	3.30E+00	1%	III
Eu-155	4.66E-03	1.56E-01	3%	III
Fe-55	6.44E-01	1.30E+03	0.05%	III
H-3	1.13E-03	3.49E-05	3230%[a]	Retained
I-129	1.81E-07	5.05E-04	0.04%	Retained
Nb-93m	4.41E-02	7.62E+01	0.1%	III
Nb-94	1.21E-03	2.28E-01	0.5%	Retained

Ni-59	1.36E-02	4.84E+00	0.3%	Retained
Ni-63	5.28E-01	4.21E+02	0.1%	III
Pu-238	7.28E-04	3.55E-02	2%	Retained
Pu-239	1.01E-05	3.15E-01	0.003%	Retained
Pu-240	1.14E-06	2.28E-03	0.1%	Retained
Pu-241	7.71E-04	2.07E-01	0.4%	Retained
Sb-125	2.53E-01	8.15E+00	3%	III
Sr-90	1.65E-02	6.42E+02	0.003%	III
Tc-99	1.86E-03	3.11E+00	0.1%	Retained
U-233	8.70E-06	4.61E-06	189%[a]	III
U-234	8.70E-06	1.25E-04	7%	Retained
U-235	4.13E-06	3.70E-03	0.1%	Retained
U-236	4.13E-06	2.32E-06	178%[a]	III

a. Ratio > 10%. Additional evaluation required.

Cm-245, Eu-152, U-233 and U-236

The activity of these four radionuclides in NRF debris is small. The ratios in Table 2 (Column 4) were large only because the activity of each radionuclide as surface contamination reported in the PA from other generators was even smaller. In the case of Eu-152, there was none reported as surface contamination in the PA making the ratio infinite. Each of these radionuclides were screened out in the PA from the all-pathway dose. Cm-245 was eliminated in the PA during the Phase II screening and the other three (Eu-152, U-233 and U-236) were eliminated during the Phase III screening. Because they were screened out, it is important to show that if the activity of these radionuclides in NRF debris were added to the radionuclide activities considered in the PA, the totals would still be screened out just as they were in the PA. This was done by comparing the total inventory of each radionuclide (PA inventory plus NRF debris) to the maximum allowable inventory allowed by the Phase II and Phase III screenings. The Phase II and III screenings were done using the total facility inventory and are independent of generator and waste form.

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

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

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 Factor for radionuclide *i* (mrem/Ci) (see DOE-ID 2018, Table 2-26).

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

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

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* (Ci) (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* (mrem/yr).

Table 3 shows that even when the activities in NRF debris (Column 2) are added to the PA base case inventories (Column 3), the totals (Column 4) are fractions of the maximum allowable Phase II and Phase III screening inventories (Column 6) and would still be screened out. Therefore, the inventories of Cm-245, Eu-152, U-233 and U-236 are within the bounds of the PA.

Table 3. Comparison of total radionuclide inventories to maximum allowable screening inventories.

1	2	3	4	5	6	7
Radionuclides Screened During PA Phase II Screening						
Radionuclide	NRF Debris (Ci)	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[a]	NRF Debris Inventory plus Total PA Base Case Inventory (Col2+Col3) (Ci)	PA Phase II NCRP Screening Factor (mrem/Ci)[b]	Max Allowable Phase II Screening Inventory (Ci/yr)[c]	NRF Debris Inventory plus Total PA Base Case Inventory as % of Max Allowable Phase II Screening Inventory (Col4/Col6)
Cm-245	1.15E-06	5.28E-07	1.68E-06	6.29E+04	6.36E-06	26.4%
Radionuclides Screened During PA Phase III Screening						
Radionuclide	NRF Debris (Ci)	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[a]	NRF Debris Inventory plus Total PA Base Case Inventory (Col2+Col3) (Ci)	PA Phase III Dose (mrem/yr)[d]	Max Allowable Phase III Screening Inventory (Ci/yr)[e]	NRF Debris Inventory plus Total PA Base Case Inventory as % of Max Allowable Phase II Screening Inventory (Col4/Col6)
Eu-152	3.77E-01	4.14E+00	4.52E+00	1.00E-40[f]	1.66E+40	<1E-40%
U-233	8.70E-06	8.38E-05	9.25E-05	2.54E-02	1.32E-03	7.0%
U-236	4.13E-06	5.88E-05	6.29E-05	1.04E-02	2.26E-03	2.8%

a. Table 2-14, RHLLW Performance Assessment (DOE-ID 2018).
b. Table 2-26, RHLLW Performance Assessment (DOE-ID 2018).
c. $Imax_{IIi}$ from Equation 1 above.
d. Table 2-29, RHLLW Performance Assessment (DOE-ID 2018).
e. $Imax_{IIIi}$ from Equation 2 above.
f. PA screening dose < 1E-40. Value set to 1E-40 for calculation using Equation 2.

H-3 (tritium)

The activity of H-3 in NRF debris is very small (1.13E-03 Ci, Table 2 Column 2). The ratio in Table 2 (Column 4) is large only because the activity of tritium as surface contamination reported in the PA from other generators was even smaller (3.49E-05 Ci). The total amount of tritium considered in the PA (all generators and waste forms) was nearly 2000 Ci. The dose contribution of H-3 to the all-pathway dose in the PA was less than 1E-20 mrem/yr. Based on this the amount of tritium in NRF debris is within the bounds of the PA. Additionally, because the dose contributions from H-3 are calculated by RHINO as part of the acceptance of each canister, the dose contribution from H-3 in NRF debris will be accounted for by RHINO.

Evaluation Summary

An evaluation of the estimated average case isotopic activity as surface contamination on NRF debris to be included in activated metal waste canisters (55-Ton and NSFH) was performed. The evaluation shows the radioactivity on NRF debris as surface contamination is within the bounds of the PA and only a small increase in the surface contamination considered in the PA base case inventory for most radionuclides. For the five radionuclides that were greater than 10% of the PA base case surface contamination inventory, the increases were within the bounds of the PA and those radionuclides that were screened out during preparation of the PA would still be screened out, and for H-3, the one radionuclide that was not screened out, the tritium inventory on NRF debris will be an insignificant dose contributor. Nevertheless, the dose contribution from tritium on NRF debris will be calculated by RHINO during canister acceptance.

Recommendations

NRF shall report the estimated surface contamination on activated metal structural (crud) and on debris when reporting radionuclide inventories for canister acceptance using reporting criteria in the WAC (PLN-5446). Use of an average case consistent with the methodology in TWR-21794 is acceptable in lieu of performing underwater surveys on each piece of debris placed in waste canisters. Each canister should be reviewed by NRF Waste Programs to ensure the average case represents the surface contamination on debris items identified for disposal. Adjustments to increase or decrease the estimated inventory are acceptable and recommended if the average case does not represent the surface contamination on debris. It is recommended that unique items that are not represented by the average case be surveyed if feasible.

It is recommended the ECF Water Pool isotopic distribution be reanalyzed every three years consistent with current NRF procedures, and the new distribution be used to adjust (if necessary) the average case isotopic distribution using methodology consistent with TWR-21794.

It is recommended the RHLLW disposal project make the following updates to documents:

- INL/EXT-18-45184, Methods, Implementation, and Testing to Support Determination of Performance Assessment Compliance for the RHLLW Disposal Facility WAC (INL 2018).
    - Table 3: Add indicial response function indicator "1" to H-3 under Surface Contamination and ensure this functionality exists in RHINO.

- PLN-5446, Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility.
    - Tables B-6 and B-8: Include radionuclides reported as surface contamination on NRF debris (TWR-21794) that are not included in the list of radionuclides reported as surface contamination crud for the PA. This includes Eu-152, Eu-154, Eu-155, H-3, Hf-175, Ru-103, Sn-113 and Ta-182.

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.

ECAR-3940, 2018, Baseline Radionuclide Inventory for the Remote-Handled Low-Level Waste Disposal Facility for Use in the Facility Performance Assessment, Idaho National Laboratory, January 2018.

NRF, 2011, "Naval Nuclear Propulsion Program Remote-Handled Low-Level Radioactive Waste Generation Data," Letter from G. F. Holden, Manager, Naval Reactors, to R. Furstenau, DOE Idaho Operations Office, NR Letter U#11-01756, April 15, 2011.

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, 2017, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 1, Idaho National Laboratory, March 2018.

RH-ADM-5214, 2021, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Idaho National Laboratory, October 2021.

TWR-21794, Water Pool Debris Contribution to RH-LLW Activity (Supplement), Technical Work Record No. 21794, Naval Reactors Facility Waste Programs.

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Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
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Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	8/22/22
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

UDQE Tracking No.: UDQE-RHLLW-053

Subject: RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide

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 MFC210277 is an HFEF-5 canister containing activated metal waste from MFC that was generated after 4/21/2015. Waste generated after 4/21/2015 is described in the RHLLW Disposal Facility performance assessment (PA) as HFEF future generation waste to distinguish it from legacy waste from the Radioactive Scrap and Waste Facility (RSWF). 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 MFC210277 was flagged by RHINO based on the following inventory checks:

PA Check 1: PA Base Case Inventory Check by Generator/Canister/Waste Form

This check was flagged by RHINO because the cumulative inventories of 11 radionuclides (Ba-137m, Np-237, Pa-233, Pu-238, Pu-240, Pu-241, Pu-242, Th-231, U-235, U-238 and Y-90) exceed the PA base-case inventories for this generator (MFC), canister type (HFEF) and waste form (activated metals[1]). The cumulative inventory includes the inventory of all placed canisters, plus the proposed canister. Of the 11 radionuclides, four (Ba-137m, Pa-233, Th-231, and Y-90) were screened out during Phase I of a three-phase screening process for the PA because their half-lives are less than one year. The inventory of these radionuclides will have no impact on the PA all-pathway dose and they do not require evaluation. Three of the remaining seven radionuclides (Pu-238, Pu-241 and Pu-242) were screened out during the PA Phase III screening and the remaining four (Np-237, Pu-240, U-235 and U-238) were not screened out during preparation of the PA and they are considered "key" radionuclides meaning their dose impacts are included in the PA all-pathway dose calculation. Non-key radionuclides that were not screened out during the Phase I screening will be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out. For key radionuclides, the cumulative inventory will be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA.

PA Check 2: Administrative 10% Canister Inventory Check (Key Radionuclides Only)

This flag was checked by RHINO because the canister inventories of eight key radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90, U-234, U-235 and U-238) 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 3: Canister Action Levels (Canister Specific)

[1] The radionuclides flagged by RHINO are all surface contamination on the activated metal waste.

This flag was checked by RHINO because the canister inventories of two key radionuclides (Cs-137 and Sr-90) exceed canister action levels based on the intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels are the array action levels (INL/EXT-18-45184, Table 20) divided by the total number of canisters that may be placed in the array. The canisters action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters.

WAC Check: WAC Nuclear Safety Limits

This flag was checked by RHINO because the canister inventories of 4 radionuclides (Cs-137, Pu-239, Sr-90 and Y-90 exceed nuclear-safety threshold levels derived in ECAR-1559 and presented in the WAC (PLN-5446, Table A-9). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the threshold levels adopted as waste acceptance criteria. If the canister inventory for one or more radionuclides exceeds threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values for that waste stream/canister combination.

Identification of Non-System Radionuclide

Waste canister MFC210277 contains Nb-91, a radionuclide that is not in the RHINO database and therefore was not considered during preparation of the PA. This was identified on the Nuclides tab under Canister Details in RHINO during acceptance testing. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility."

Exceedance of a threshold value or action level, or identification of a "non-system" or previously unanalyzed radionuclide by RHINO does not indicate a canister is unacceptable for disposal but the 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: 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 MFC210277 contains radionuclides whose inventories cause the cumulative inventory for the specific generator, canister type and waste form to exceed the cumulative base-case inventory analyzed in the PA, or result in an increase from a level that already exceeded the cumulative base-case inventory analyzed in the PA. The canister also contains radionuclides whose inventory levels exceed canister inventory threshold levels analyzed in the PA for a specific generator, canister type and waste form. The canister also contains radionuclides whose inventory levels exceed canister action levels based on intruder pathway dose standards. The canister contains radionuclide inventories that exceed nuclear safety threshold levels in the WAC (PLN-5446). A UDQE is recommended to address each of these issues.

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	12/13/2021
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Tim Arsenault	12/13/2021
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: See Explanation below

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

   Yes ☐ No ☒

   Comments: See Explanation below

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 contains an evaluation of the three failed PA checks, an evaluation of the failed WAC check, and an evaluation of the non-system radionuclide identified by RHINO.

PA Checks

The three PA inventory checks flagged by RHINO on waste canister MFC210277 are highlighted yellow in the RHINO output shown in Figure 1 and the detailed results from each check are shown at the lower part of the figure. PA checks numbered 9 and 10 in Figure 1 are the same check but the results for key and non-key radionuclides are shown in separate rows. Evaluations of each of these flagged checks is included below.

Canister Details MFC210277

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	4.7699E-005	1	mrem/yr	Compliance	10/6/2021
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	10/6/2021
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	10/6/2021
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	10/6/2021
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	10/6/2021
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	10/6/2021
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	10/6/2021
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	10/6/2021
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	10/6/2021
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	10/6/2021
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	10/6/2021
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	10/6/2021
7	Yes	Intruder	1.5245E-002	20	mrem/yr	Compliance	10/6/2021
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	10/6/2021
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	10/6/2021
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	10/6/2021
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	10/6/2021
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	10/6/2021
13	No	Canister Action Levels Check	-			Compliance	10/6/2021

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1021E+000	1.3503E-002	2.0100E+000
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	1.4100E-006
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	1.4100E-006
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	4.7900E-004
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	4.7200E-004
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	3.4700E-004
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	4.7200E-008
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	1.7500E-006
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	1.7500E-006
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	1.0000E-006
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9435E+000	1.6513E+000	2.6900E+000

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	MFC	HFEF-5 Can	2	2.1200E+000	3.3072E+000	3.3072E-001
Np-237	S	MFC	HFEF-5 Can	2	1.4100E-006	6.8565E-008	6.8565E-009
Pu-239	S	MFC	HFEF-5 Can	2	4.8700E-003	1.5644E-002	1.5644E-003
Pu-240	S	MFC	HFEF-5 Can	2	4.7200E-004	6.1053E-005	6.1053E-006
Sr-90	S	MFC	HFEF-5 Can	2	2.6900E+000	6.7841E+000	6.7841E-001
U-234	S	MFC	HFEF-5 Can	2	7.0900E-005	1.1728E-004	1.1728E-005
U-235	S	MFC	HFEF-5 Can	2	1.7500E-006	1.8102E-006	1.8102E-007
U-238	S	MFC	HFEF-5 Can	2	1.0000E-006	9.1146E-007	9.1146E-008

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Cs-137	HFEF-5 Can	2.1200E+000	3.4000E-001
Sr-90	HFEF-5 Can	2.6900E+000	6.9700E-001

Figure 1. PA Check output screen from RHINO for waste canister MFC210277.

PA Check 1: PA Base Case Inventory Check by Generator/Canister/Waste Form

This check was flagged by RHINO because the cumulative inventories of 11 radionuclides (Ba-137m, Np-237, Pa-233, Pu-238, Pu-240, Pu-241, Pu-242, Th-231, U-235, U-238 and Y-90) exceed the PA base-case inventories for this generator/canister/waste form (DOE/ID-11421) (see Figure 1, Column 1, Numbers 9 and 10). The cumulative inventories includes the inventories of all placed canisters, plus the proposed canister MFC210277. According to INL/EXT-18-45184 (2018), the cumulative radionuclide inventory for each generator/canister/waste form must not exceed the PA base case inventories in Table 18. If this occurs, the cumulative inventory is evaluated to determine if the inventory is within the bounds of the PA.

Of the 11 radionuclides flagged, four (Ba-137m, Pa-233, Th-231, and Y-90) were screened out during phase I of a three-phase screening process for the PA because their half-lives are less than one year. The inventory of these radionuclides will have no impact on the PA all-pathway dose and they do not require evaluation.

Three of the remaining seven radionuclides (Pu-238, Pu-241 and Pu-242) were screened out during the PA third screening phase and the remaining four (Np-237, Pu-240, U-235 and U-238) were not screened out during preparation of the PA and they are considered "key" radionuclides meaning their dose impacts are included in the PA all-pathway dose calculation. Non-key radionuclides that were not screened out during the Phase I screening will be evaluated to determine if the increase in inventory (above the PA base case) could have resulted in the radionuclide not being screened out. For key radionuclides, because the cumulative generator/canister/waste form-specific inventory exceeds the PA base case inventory in Table 18 of INL/EXT-18-45184 (2018), the cumulative inventory will be evaluated to determine if the inventory and accompanying increase in dose is within the bounds of the PA.

Non-key radionuclides screened during PA Phase III screening

The cumulative inventories (placed + proposed) of the three non-key radionuclides (Pu-238, Pu-241 and Pu-242) were examined to determine if the cumulative inventories would have impacted the screening in the PA. This was done by calculating the cumulative inventory of each radionuclide as a percent of the maximum allowable inventory allowed by the Phase III PA screening. The maximum allowable inventory allowed by the Phase III screening was calculated using the following equation:

$$Imax_i(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \frac{I_{PAi}\,(Ci)}{D_{IIIi}(\frac{mrem}{yr})} \quad \text{(Equation 1)}$$

where:

$Imax_i$ = maximum inventory of radionuclide i that would still be screened out during the Phase III PA screening

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 (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 the projected cumulative inventories of each radionuclide (Column 3) are very small fractions (< 0.01%, Column 7) of the maximum allowable inventory (Column 6) and would still be screened out during the Phase III PA screening. Therefore, the inventories of Pu-238, Pu-241 and Pu-242 in canister MFC210277 will not impact the PA.

Table 1. Summary of non-key radionuclide inventory evaluation for PA Check 1.

1	2	3	4	5	6	7
Non-Key Radionuclide	Canister MFC210277 Inventory (Ci)	Projected Cumulative Inventory (Placed + Proposed Canister MFC210277) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	PA Phase III Screening Dose (mrem/yr)[c]	Max Allowable Inventory That Would Still be Screened in Phase III (Ci)[d]	Projected Cumulative Inventory as % of Max Allowable Phase III Inventory
Pu-238	4.79E-04	5.38E-04	3.68E-01	0.0257	5.73	0.00939%
Pu-241	3.47E-04	4.34E-04	1.97E+01	0.0432	182	0.00024%
Pu-242	4.72E-08	5.79E-08	2.27E-04	0.015	0.0061	0.00096%

a. From RHINO acceptance check, see Figure 1.
b. Table 2-14, RHLLW Performance Assessment (DOE/ID-11421).
c. Table 2-29, RHLLW Performance Assessment (DOE/ID-11421).
d. $Imax_i$ from Equation 1 above.

Key radionuclides

The remaining four radionuclides (Np-237, Pu-240, U-235 and U-238) are key radionuclides meaning they were not screened out during preparation of the PA and dose impacts are included in the PA all-pathway dose. Even before disposal of canister MFC210277, the cumulative inventory of Np-237 and Pu-240 in the RHLLW disposal facility already exceeds the PA base-case inventory for this generator/canister/waste form (see UDQE-RHLLW-046, or subtract Column 2 from Column 3 and compare to Column 4 in Table 2). Thus, the amounts in canister MFC210177 would only add to this exceedance. The U-235 and U-238 inventory in canister MFC210277 would cause the cumulative inventory to exceed the PA base-case inventory for this generator/canister/waste form.

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 comparing the projected dose and concentration impacts to the performance objectives (Figure 1, Column 1 numbers 1-7). Table 2 shows the all-pathway dose impact before and after disposal of canister MFC210277. The projected all-pathway dose after disposal of canister MFC210277 is only predicted to increase 0.002% during the compliance period and 0.007% during the post-compliance period. The predicted total dose during both periods is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The other doses and concentrations are also much less than performance objectives as shown in Figure 1.

Table 2. All-pathway dose impact after disposal of canister MFC210277.

Time Period	All-Pathway Dose Before Disposal of MFC210277 (mrem/yr)[a]	All-pathway Dose after Disposal of MFC210277 (mrem/yr)	% Increase in Dose After Disposal of MFC210277
Compliance Period	4.7698E-05	4.7699E-05	0.002%
Post-Compliance Period	2.7776E-02	2.7778E-02	0.007%

a. After disposal of MFC200361

In addition to comparing the projected doses and concentrations to performance objectives, the projected cumulative inventories for the specific generator/canister/waste form were compared to the total facility PA base-case inventories for the specific waste form (surface contamination) and to the total facility PA base-case inventories for all waste forms. This is done to ensure that the increase in inventory is unlikely to impact the projected waste shipments from other generators. Table 3 shows the projected cumulative inventories as surface contamination are small percentages of the PA base case inventories as surface contamination for each radionuclide except Pu-240 which is 25.4% of the PA base case (Column 6 = Column 3 ÷ Column 5). However,

the projected cumulative inventory of all four key radionuclides are very small percentages of the PA base case inventories of all waste forms (Column 8 = Column 3 ÷ Column 7). Based on these low percentages, the impact on performance objectives is expected to be minimal which is demonstrated by Table 2; and the increased inventory will not impact the amount of waste expected to be shipped by other generators.

Table 3. Summary of key radionuclide inventory evaluation for PA Check 1.

1	2	3	4	5	6	7	8
	Surface Contamination					All Waste Forms	
Radionuclide	Canister MFC210277 Inventory (Ci)	Projected Cumulative Inventory (MFC, HFEF-5 Canisters)[a] (Ci)	PA Base-Case Inventory (MFC, HFEF-5 Canisters)[b] (Ci)	PA Base-Case Inventory (All Generators & Canisters) (Ci)	Projected Cumulative Inventory as % of PA Base Case Inventory (All Generators & Canisters)	PA Base-Case Inventory (All Generators, Canisters) (Ci)	Projected Cumulative Inventory as % of PA Base Case Inventory (All Generators & Canisters)
Np-237	1.41E-06	1.75E-06	6.86E-08	5.82E-04	0.301%	6.95E-04	0.252%
Pu-240	4.72E-04	5.79E-04	6.11E-05	2.28E-03	25.4%	1.76E-01	0.329%
U-235	1.75E-06	2.33E-06	1.81E-06	3.70E-03	0.063%	3.71E-03	0.063%
U-238	1.00E-06	1.24E-06	9.11E-07	7.41E-04	0.168%	8.76E-04	0.142%

a. Includes legacy (before 4/21/15) and future generation (after 4/21/15) waste (see INL/EXT-18-45184). However, there was no Np-237 listed in future generation waste in the PA base-case inventory.
b. Table 2-14, RHLLW Performance Assessment (DOE/ID-11421).

PA Check 2: Administrative 10% Canister Inventory Check (Key Radionuclides Only)

This flag was checked by RHINO because the canister inventories of eight key radionuclides (Cs-137, Np-237, Pu-239, Pu-240, Sr-90, U-234, U-235 and U-238) 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 activity 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.

Table 4 contains a summary of the flagged radionuclide inventories in canister MFC210277 compared to PA base-case inventories for: 1) the specific generator/canister/waste form, and 2) all generators, canister types and waste forms. Column 4 shows that all canister inventories are greater than 10% of the PA base-case inventories for the specific generator/canister/waste form. Np-237 and Pu-240 are much greater at 2056% and 773% respectively (cells shaded yellow). When compared to the total PA base case inventory of surface contamination for all generators and canister types, the canister inventory is a small percent except for Pu-240 and U-234 at 20.7% and 56.7% respectively (pink shaded cells). And when compared to the total PA base case inventory of all generators, canister types and waste forms, the percentages are all less than 1% with the exception of U-234 (11.6%, purple shaded cell).

Canister MFC210277 is only the fourth canister of new-generation (non-legacy) waste from MFC submitted for disposal. The surface contamination inventories in the three previous canisters (MFC170305, MFC190345 and MFC200361) contained one to three key radionuclides above the 10% threshold inventory levels.
The discrepancy in the inventories between the four new-generation waste canisters and PA base-case inventories is likely related to the generating facility at MFC and the waste type. The four canisters of new-generation waste at the RHLLW disposal facility (3 placed, 1 proposed) were loaded at the Fuel Conditioning Facility (FCF) at MFC. Of the 23 legacy waste canisters used to estimate the inventory of new-generation waste for the PA, 22 were loaded with waste from the Hot-Fuel Examination Facility (HFEF) hot cell. These were the most recently loaded

waste canisters at MFC prior to developing the source term for the PA. Although the cell waste at both HFEF and FCF are similar, there are some differences that could explain the discrepancy. For example, both facilities contain irradiated metals and EBR-II hardware, but HFEF contains more post-irradiation-examination research waste categorized as combination waste (activated metal and surface contaminated debris). So, while the inventories in canister MFC210277 are not anomalous when compared to the other HFEF-5 new-generation waste canisters, all four of the new-generation waste canisters contain radionuclides at elevated levels from what was analyzed in the PA. A recommendation has been made to reexamine the projected inventory for future generation waste from MFC.

Table 4. Radionuclide inventory summary for PA Check 2.

		Surface Contamination				All Waste Forms	
Radionuclide	Canister MFC210277 Inventory (Ci)	Total PA Base Case Inventory (MFC, HFEF-5 Canisters) (Ci)[a]	Canister Inventory as % of PA Inventory for MFC HFEF-5 Canisters	Total PA Inventory (All Generators, All Canisters) (Ci)[b]	Canister Inventory as % of Total PA Base Case Inventory for all Generators and Canisters	Total PA Base Case Inventory (All Generators, Canisters, and Waste Forms) (Ci)[c]	Canister Inventory as % of Total PA Base Case Inventory (All Generators, Canisters, and Waste Forms)
Cs-137[d]	2.12E+00	3.31E+00	64.1%	918	0.231%	9.45E+02	0.22%
Np-237	1.41E-06	6.86E-08	2056%	5.82E-04	0.242%	6.95E-04	0.20%
Pu-239	4.87E-03	1.56E-02	31.1%	3.15E-01	1.55%	5.56E-01	0.88%
Pu-240	4.72E-04	6.11E-05	773%	2.28E-03	20.7%	1.76E-01	0.27%
Sr-90[d]	2.69E+00	6.78E+00	39.7%	6.42E+02	0.419%	6.73E+02	0.40%
U-234	7.09E-05	1.17E-04	60.5%	1.25E-04	56.7%	6.09E-04	11.6%
U-235	1.75E-06	1.81E-06	96.7%	3.70E-03	0.047%	3.71E-03	0.05%
U-238	1.00E-06	9.11E-07	109.7%	7.41E-04	0.135%	8.76E-04	0.11%

a. Includes legacy (before 4/21/15) and new-generation (after 4/21/15) waste (see INL/EXT-18-45184).
b. Table 2-14, Column 3, RHLLW Performance Assessment (DOE/ID-11421).
c. Table 2-14, Column 5, RHLLW Performance Assessment (DOE/ID-11421).
d. Cs-137 and Sr-90 are only important for the PA intruder dose calculation. They are not included in the PA all-pathway dose calculation.

PA Check 3: Canister Action Levels (Canister Specific)

This flag was checked by RHINO because the canister inventories of two key radionuclides (Cs-137 and Sr-90) exceed canister action levels based on the intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels are the array action levels (INL/EXT-18-45184, Table 20) divided by the total number of canisters that may be placed in the array. Thus, the canister action levels are indicative of levels that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters.

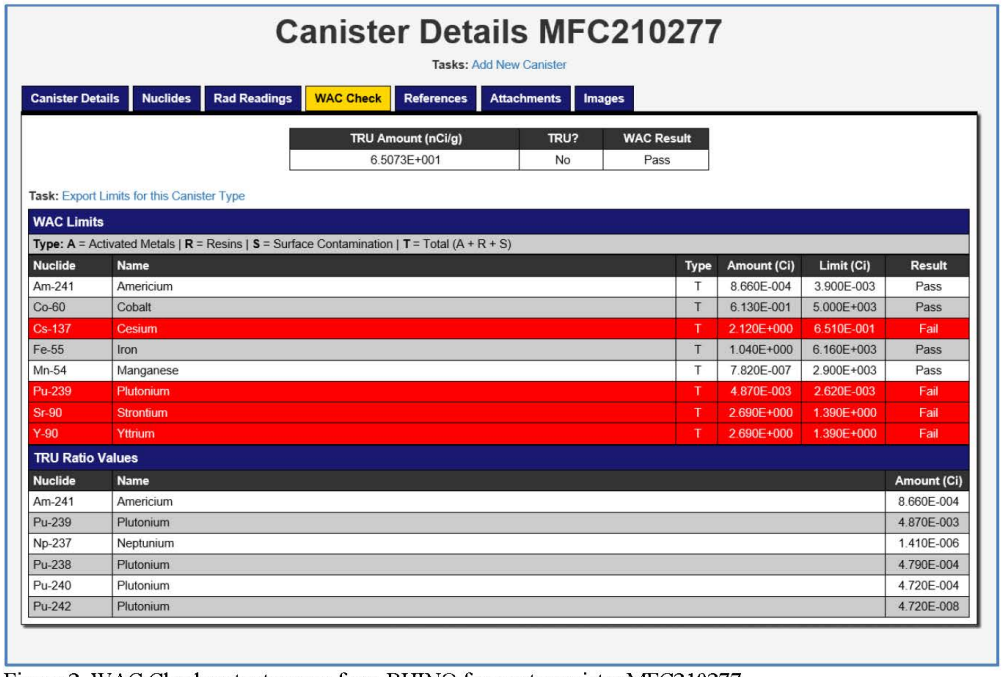
The inventories of Cs-137 and Sr-90 in canister MFC210277 exceed the action levels for a canister, but the cumulative inventories (placed + proposed) do not exceed the array action levels. Table 5 shows the Cs-137 and Sr-90 cumulative inventories (Column 4) are 5.35% and 3.18% respectively (Column 6) of the vault array action levels (Column 5). MFC210277 would be the 45th HFEF canister in the HFEF vault array which is 25% of the 180-canister capacity, yet the Cs-137 and Sr-90 cumulative inventories are much smaller percentages of the vault array action levels. This is because most of the 41 legacy canisters that have been placed contain much less Cs-137 and Sr-90 than the average canister action level. Based on this, the Cs-137 and Sr-90 inventory in canister MFC210277 will not impact the conclusions of the PA.

Table 5. Radionuclide inventory evaluation for PA Check 3.

1	2	3	4	5	6
Radionuclide	Canister MFC210277 Inventory (Ci)	Cumulative Placed Inventory Prior to MFC210177	Cumulative Placed + Proposed Inventory with MFC210277	Total Vault Array Action Level	Cumulative Placed + Proposed Inventory with MFC210277 as % of Total Vault Array Action Level
Cs-137	2.12	1.15	3.27	61.2	5.35%
Sr-90	2.69	1.28	3.97	125	3.18%

WAC Check: Nuclear Safety Limits

The radionuclide inventories flagged by RHINO on waste canister MFC210277 as part of the WAC check are highlighted red in the RHINO output shown in Figure 2. The canister inventories of Cs-137, Pu-239, Sr-90 and Y-90 were flagged as "fail" because they exceed the bounding material at risk (MAR) levels evaluated in ECAR-1559 and identified as waste acceptance criteria in the WAC (PLN-5446, Table A-9). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the bounding MAR (threshold levels). If the canister inventory for one or more radionuclides exceeds the threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values evaluated for that waste stream/canister combination. In addition, the cause of each high radionuclide outlier should be investigated to determine if (1) the corresponding waste stream processes have been changed such that the characterization as provided in ECAR-1559 and supporting ECARs is no longer valid and needs updating, or (2) the outlier is attributable to an anomalous condition that is unique to this specific proposed canister.



Canister Details MFC210277

Tasks: Add New Canister

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

TRU Amount (nCi/g)	TRU?	WAC Result
6.5073E+001	No	Pass

Task: Export Limits for this Canister Type

WAC Limits

Type: A = Activated Metals | R = Resins | S = Surface Contamination | T = Total (A + R + S)

Nuclide	Name	Type	Amount (Ci)	Limit (Ci)	Result
Am-241	Americium	T	8.660E-004	3.900E-003	Pass
Co-60	Cobalt	T	6.130E-001	5.000E+003	Pass
Cs-137	Cesium	T	2.120E+000	6.510E-001	Fail
Fe-55	Iron	T	1.040E+000	6.160E+003	Pass
Mn-54	Manganese	T	7.820E-007	2.900E+003	Pass
Pu-239	Plutonium	T	4.870E-003	2.620E-003	Fail
Sr-90	Strontium	T	2.690E+000	1.390E+000	Fail
Y-90	Yttrium	T	2.690E+000	1.390E+000	Fail

TRU Ratio Values

Nuclide	Name	Amount (Ci)
Am-241	Americium	8.660E-004
Pu-239	Plutonium	4.870E-003
Np-237	Neptunium	1.410E-006
Pu-238	Plutonium	4.790E-004
Pu-240	Plutonium	4.720E-004
Pu-242	Plutonium	4.720E-008

Figure 2. WAC Check output screen from RHINO for waste canister MFC210277.

ECAR-5771 documents the full dose consequence evaluation for canister MFC210277. According to ECAR-5771, the potential dose consequence from fire and drop accidents involving MFC210277 canister are less than the maximum hypothetical dose evaluated in SAR-419, upon which facility safety controls were evaluated (see Table 6). Because the safety basis bounds the potential accident doses for canister MFC210277, the canister is deemed acceptable for disposal from a safety basis perspective.

Table 6. Dose consequences from postulated accidents compared to maximum hypothetical dose evaluated in SAR-419.

Canister Fire	SAR-419 HFEF-5 (rem)[a]	MFC210277 (rem)
Collocated worker dose (100m)	1.5E-02	1.07E-04
Public dose (10,900 m)	1.1E-04	1.23E-06
Canister Drop	**SAR-419 HFEF-5 (rem)[b]**	**MFC210277 (rem)**
Collocated worker dose (100m)	1.5E+00	2.18E-03
Public dose (10,900 m)	1.1E-02	2.48E-05

a. SAR-419 Table 3-12
b. SAR-419 Table 3-14

Canister MFC210277 would be the 45th HFEF-5 canister to be placed at the facility and is the first to exceed WAC threshold levels. By that standard the four radionuclide inventories that exceed WAC threshold levels are outliers. However, as discussed previously (see PA Check 2), all four of the new-generation waste canisters contain radionuclides at elevated levels from what was analyzed in the PA. Because of that, a recommendation has been made to reexamine the projected inventory for future generation waste from MFC. Once that is done, the updated projected inventory will be evaluated to determine if a new bounding MAR should be determined for safety basis acceptance screening. This would involve an update of ECAR-1559 and the values in table A-9 of the WAC (PLN-5446).

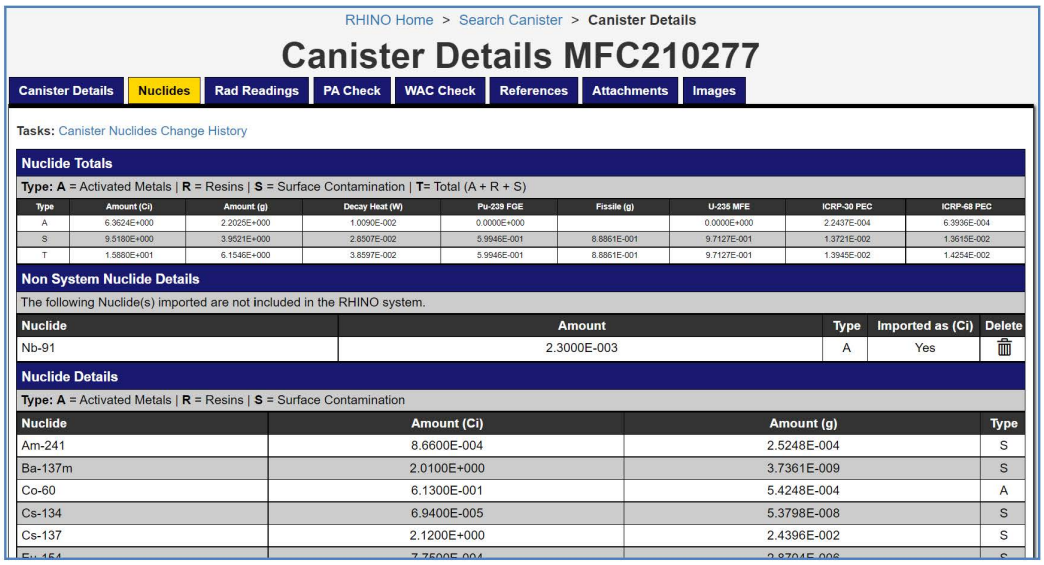
Identification of Non-System Radionuclide

Waste canister MFC210277 is estimated to contain 0.0023 Ci of Nb-91, a radionuclide that is not in the RHINO database (i.e., "non-system" radionuclide) and was not considered during preparation of the PA. This radionuclide was identified on the Nuclides tab in RHINO under Canister Details (see Figure 3). According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility."

The Nb-91 inventory was analyzed to determine if it is within the bounds of the PA for both the groundwater and intruder pathways. The analyses were peer reviewed by Arthur S. Rood of K-Spar Inc., a co-author of the PA. His review comments and approval email are attached to the canister MFC210277 documentation in RHINO.

Groundwater Pathway—The PA performed three phases of radionuclide screening for the groundwater pathway. Nb-91 would not have been screened during the Phase I screening because the half-life (680 years) is greater than 1 year. It would also not have been screened during the Phase II screening because there is no National Council on Radiation Protection screening factor for Nb-91 (NCRP 1996). Therefore, the Nb-91 inventory in canister MFC210277 was modeled using the PA Phase III screening model GWSCREEN (Version 2.5a, Rood 2003) using the same site-specific parameters (see DOE/ID-11421, Section 2.6.3). The GWSCREEN input file was modified to include the Nb-91 information shown in Table 7. The GWSCREEN results indicate the estimated activity in canister MFC210277 (0.0023 Ci) would result in a negligible groundwater ingestion dose of 9.9E-27 mrem, and without solubility limitations the facility could accept up to 9E+16 Ci of Nb-91 and not exceed the Phase III dose

limit criteria of 0.4 mrem/yr. Actual solubility limitations would increase this amount. Therefore, any realistic amount of Nb-91 would have been screened from further consideration and is within the bounds of the PA.



RHINO Home > Search Canister > **Canister Details**

Canister Details MFC210277

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

Tasks: Canister Nuclides Change History

Nuclide Totals

Type: A = Activated Metals | **R** = Resins | **S** = Surface Contamination | **T**= Total (A + R + S)

Type	Amount (Ci)	Amount (g)	Decay Heat (W)	Pu-239 FGE	Fissile (g)	U-235 MFE	ICRP-30 PEC	ICRP-68 PEC
A	6.3624E+000	2.2025E+000	1.0090E-002	0.0000E+000		0.0000E+000	2.2437E-004	6.3936E-004
S	9.5180E+000	3.9521E+000	2.8507E-002	5.9946E-001	8.8861E-001	9.7127E-001	1.3721E-002	1.3615E-002
T	1.5880E+001	6.1546E+000	3.8597E-002	5.9946E-001	8.8861E-001	9.7127E-001	1.3945E-002	1.4254E-002

Non System Nuclide Details

The following Nuclide(s) imported are not included in the RHINO system.

Nuclide	Amount	Type	Imported as (Ci)	Delete
Nb-91	2.3000E-003	A	Yes	

Nuclide Details

Type: A = Activated Metals | **R** = Resins | **S** = Surface Contamination

Nuclide	Amount (Ci)	Amount (g)	Type
Am-241	8.6600E-004	2.5248E-004	S
Ba-137m	2.0100E+000	3.7361E-009	S
Co-60	6.1300E-001	5.4248E-004	A
Cs-134	6.9400E-005	5.3798E-008	S
Cs-137	2.1200E+000	2.4396E-002	S

Figure 3. Nuclides tab from RHINO for waste canister MFC210277 showing identification of Nb-91 as a non-system radionuclide.

Table 7. GWSCREEN parameters for Nb-91.

Parameter	Value	Reference
Half Life	680 years	FGR-15, Table A-1
Sorption Coefficient	100 ml/gm	DOE/ID-11421, Table 2-28
Dose Coefficient	3.52E-11 Sv/Bq (130.24 mrem/Ci)[a]	DOE-STD-1196-2021, Table A-1
Solubility Limit	1E+99 mg/l	Large value used for conservatism

a. The RHLLW PA Phase III screening used Reference Person water ingestion dose coefficients from DOE-STD-1196-2011. This value is from the updated standard (DOE-STD-1196-2021) and used the "Per Capita" dose coefficient.

Intruder Pathway—The impact of Nb-91 on the intruder pathway was determined by modeling Nb-91 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). Table 8 contains the maximum PA intruder doses, PA intruder dose limits, and a summary of the Nb-91 intruder dose results. Calculations show the estimated 0.0023 Ci of Nb-91 in canister MFC210277 would result in an acute dose of 8.03E-08 mrem at 100 years, and a chronic dose of 6.79E-08 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. The dose contribution from the Nb-91 is insignificant compared to the PA dose limits of 500 mrem (acute) and 100 mrem/yr (chronic). The RESRAD results were also used to determine the amount of Nb-91 that could be disposed of and result in a dose of 1 mrem for the acute intruder, and 1 mrem/yr for the chronic intruder. According to the last column in Table 8, the limiting amount of 28,600 Ci is determined by the acute intruder scenario, and this is more than 10 million times the amount in canister MFC210277. Therefore, the Nb-91 in canister MFC210277 will have no impact on the conclusions of the PA.

Table 8. Intruder dose summary for Nb-91.

Intruder Scenario	PA Maximum Total Intruder Dose[a]	PA Total Dose Limit (mrem/yr)	Dose-to-Source Ratio for Nb-91 from RESRAD at 100 years[a,b]	Dose Contribution from 0.0023 Ci Nb-91 in MFC210277 at 100 years[a]	Nb-91 Inventory Resulting in Dose of 1 mrem (Acute) and 1 mrem/yr (Chronic) at 100 years[a] (Ci)
Acute	3.19 mrem	500 mrem	3.97E-05	8.03E-08 mrem	2.86E+04
Chronic	5.42 mrem/yr	100 mrem/yr	4.69E-03	6.79E-08 mrem/yr	3.39E+04

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.
b. Dose-to-Source ratio units are mrem per pCi/g for the acute intruder and mrem/yr per pCi/g for the chronic intruder.

Summary— The radionuclide inventories in canister MFC210277 flagged by RHINO have been evaluated with respect to potential impacts on the PA; and with respect to nuclear safety threshold levels in the WAC. Based on the evaluation, impacts to the PA are small and within the bounds of the PA, and potential dose consequences are within the bounds of the safety basis. Therefore, canister MFC210277 is deemed acceptable for disposal. However, the inventory of several radionuclides in the new-generation waste from FCF are much greater than the projected inventory used for the PA. Therefore, it is recommended the projected PA base case inventory estimate for the new-generation waste stream be reevaluated to determine the potential impacts to the PA, and if a new bounding MAR is required for safety basis acceptance screening. It is also recommended that RHINO be modified to identify non-system radionuclides on the PA Check tab as unanalyzed radionuclides.

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Jonathan Jacobson	Jonathan Jacobson	12/13/2021
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
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Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
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Amy M. Cox	Amy M. Cox	12/13/2021
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Tim Arsenault	12/13/2021
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-054

Subject: Proposed changes to the RHLLW Disposal Facility change control process document SD-52.1.4

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:

SD-52.1.4 has been updated to include mandatory UDQSs of all RHINO software change requests (SCRs) consistent with the decision discussed in the FY 2019. Additionally, SD-52.1.4 is being changed from a sitewide standard directive (SD) to a facility administrative procedure document (ADM) at the request of the MFC associate laboratory director. The changes included formatting changes and a new document number. The new document will be identified as RH-ADM-5214. Revision to a technical basis document are evaluated through the change control process to determine the potential impacts to the PA and 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:

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:

After a review of the changes with respect to the screening questions above, it has been determined that none of the proposed changes has the potential to affect the assumptions and/or conclusions of the PA or CA. Updating the change control process document to include mandatory screening and changing the document from a standard directive (SD) to an administrative document (ADM) changes does not have the potential to affect the assumptions and/or conclusions of the PA or CA. Based on this determination, it is recommended the UDQS screen negative and no further evaluation is required.

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	1/31/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	1/31/2022
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	Signature	Date
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
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	Signature	Date
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-056

Subject: Review INL Comprehensive Land Use and Environmental Stewardship Report

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:

RH-ADM-5214, Section 3.1 requires a mandatory Unreviewed Disposal Question Screening (UDQS) for any proposed change to DOE Order 435.1 Disposal Compliance Documentation or other related INL documents that have the potential to impact the assumptions and/or conclusions of the PA or CA. One of the documents specifically identified is the INL Comprehensive Land Use and Environmental Stewardship (CLUES) report. The CLUES report is a summary document of the land use and environmental stewardship activities occurring on the INL Site and the Research and Education Campus within Idaho Falls. The RHLLW Disposal Facility and associated long-term controls were added to the recently revised CLUES report (INL/EXT-20-57515, 2020).

Per RH-ADM-5214, the updated CLUES report was reviewed to determine if land use activities, planning assumptions, and decisions are consistent with the assumptions in the RHLLW Disposal Facility PA, CA and closure plan. The review found that land and facility use planning and decisions at the INL Site support the INL Ten-Year Site Plan and are guided by a comprehensive site planning process in accordance with U.S. Department of Energy Order 430.1B, "Real Property Asset Management." Important land use assumptions and decisions directly and indirectly related to the RHLLW Disposal Facility were identified and include the following:

- The INL Site and its associated 889 square miles will remain under federal government management and control at least through the year 2095.
- Portions of the INL Site will remain under federal government management and control in perpetuity.
- The DOE-EM footprint will be reduced at the INL Site as the DOE-EM cleanup mission continues to completion in the year 2035.
- New buildings will be constructed to provide state- of-the-art research capabilities that are necessary to fulfill the INL Site mission.
- New building construction may include structures in existing facility areas and construction of new facility areas.
- To the extent practical, new building construction will be encouraged in existing facility areas (i.e., the REC in Idaho Falls and the Advanced Test Reactor [ATR] Complex and the Materials and Fuels Complex [MFC] at the INL Site) to take advantage of existing infrastructure.
- Construction of new facility areas should occur in the identified core infrastructure areas.
- The federal government will authorize and appropriate sufficient funds to provide adequate controls (i.e., institutional controls or engineered barriers) for areas that pose a significant health or safety risk to the public and workers until the risk diminishes to an acceptable level for the intended purpose.
- No residential development will occur within INL Site boundary, although potential development may occur in Idaho Falls.
- To protect human health and the environment, INL Site operations, including onsite disposal, will remain in full compliance with applicable environmental laws, regulations, and other requirements.
- Many locations at the INL Site will require long-term stewardship because residual contamination will remain at levels that prohibit unrestricted access. INL expects to have responsibility for long-term stewardship of the INL Site once the DOE-EM cleanup mission is complete. The INL Site, as part of its overall landlord responsibility, will manage these activities.
- Upon closure the RHLLW Disposal Facility will require long-term surveillance, maintenance, monitoring and institutional controls to enforce land use restrictions and ensure the closure concept meets performance objectives. DOE plans to maintain control of the site indefinitely but will meet all established requirements for transfer of a federal facility if another government agency should assume responsibility.

Based on the review and the assumptions listed above, it was determined that current land use activities, planning and decisions described in the CLUES report are consistent with the assumptions RHLLW Disposal Facility PA, CA and closure plan. No impacts to the PA and CA are anticipated based on the information reviewed.

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	03/31/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	4/21/22
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	Signature	Date
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
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	Signature	Date
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-059

Subject: MFC legacy waste radiological characterization methodology evolution

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:

Remote-Handled Low-Level Waste (RH-LLW) has been packaged as early as 1965 at the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL) and will continue to be packaged in the future. RH-LLW canisters have been generated from both Hot Fuel Examination Facility (HFEF) and Fuel Conditioning Facility (FCF) at MFC. The RH-LLW canisters generated from HFEF and FCF have been stored at the nearby Radioactive Scrap and Waste Facility (RSWF). RSWF currently provides interim storage capabilities for RH-LLW, Spent Nuclear Fuel, accountable nuclear materials, and various radioactive wastes. Historical records have been utilized to provide and track radionuclide inventories for each RH-LLW canister. These records include waste container logs, facility custodian records, process worksheets, and project files such as the Form 110 and Radiological Material Transfer Form (FRM-381). The historical record inventory estimates were originally stored in the HERO database, and supporting documentation was archived. Subsequently, the Searchable Liner Online (SEALION) database was developed to provide a permanent repository for the information records. RH-LLW canisters stored at RSWF and generated prior to 4/21/2015 are considered legacy waste per PLN-5446 "RHLLW Disposal Facility Waste Acceptance Criteria."

Currently, 42 HFEF-5 canisters of legacy waste from RSWF have been properly characterized, shipped and disposed of at the RHLLW disposal facility. MFC waste management personnel document radiological characterization data using Engineering Calculation and Analysis Reports (ECARs). The ECARs document the methodology used to determine the final radiological source term for individual canisters generated at MFC. The following is the list of ECARs that have been completed for legacy waste canisters from MFC that have been disposed of at the RHLLW disposal facility. Waste canister identification numbers are listed in parentheses following each ECAR.

FY-2019:
- **ECAR-4253.R3** (SN78, SN-82, SN-83, SN-84, SN-85, SN-87, SN-88, SN-89, SN-91, SN-92, SN-112, SN-118, SN-123)
- **ECAR-4562** (SN-79)

FY-2020:
- **ECAR-5090.R1** (SN-86, SN-90, SN-93, SN-97, SN-100, SN-101, SN-102, SN-103, SN-111, SN-113, SN-119, SN-122, SN-126, N-103)

FY-2021
- **ECAR-5546** (B-307, OWC001, OWC003, OWC020, OWC021, SN-99, SN-108, SN-109, SN-110, SN-116, SN-117, SN-120, SN-124, SN-137)

The methodology used to characterize the 42 legacy HFEF-5 waste canisters has been consistent during the three-year period FY-2019 through FY-2021. Legacy waste containers were removed from interim storage and surveyed to determine on-contact dose rates. Scale factors for estimating the inventory were developed by using the maximum on-contact dose rate. Waste canisters designated for disposal in FY-2022 and beyond will be characterized using an average on-contact dose rate rather than the maximum. The first ECAR to use this revised process is ECAR-5970 which documents the waste inventory for 10 RH-LLW canisters to be disposed of in FY-2022. Because all HFEF-5 legacy waste containers disposed of beginning in FY-2022 will be characterized using a modification to the previously used method, the revised methodology will be evaluated to ensure it will not result in changes that could impact the ability of the disposal facility to meet the RHLLW disposal facility WAC or alter conditions of the DAS.

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: Need to ensure the change to the methodology for legacy RH-LLW HFEF-5 canisters is appropriate to RHLLW waste acceptance requirements and documented with sufficient detail to ensure objectives of the facility requirements will be met.

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	5/24/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault	5/24/2022
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 ☒

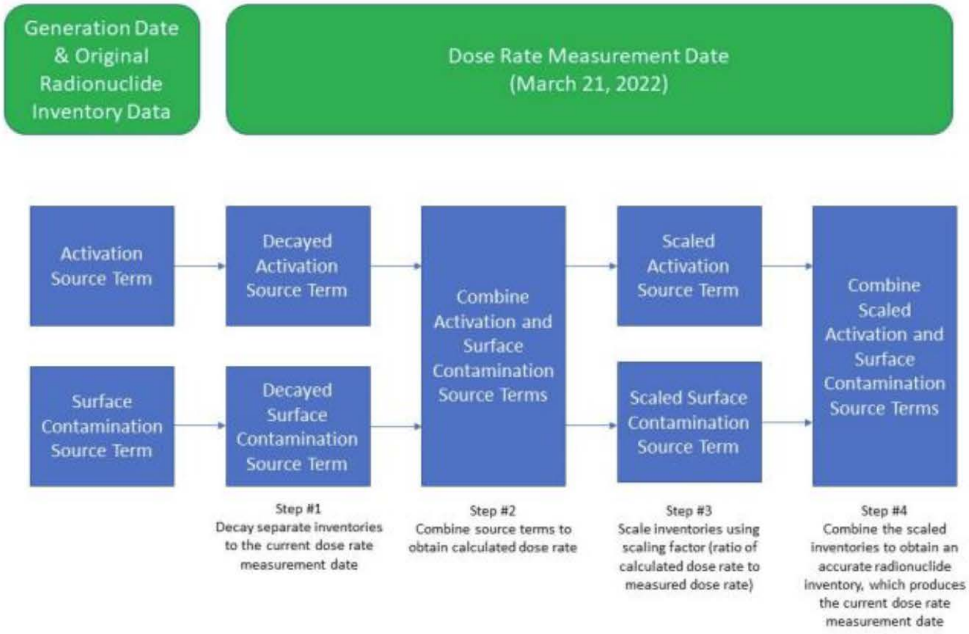
If "Yes," Special Analysis and DOE NE-ID notification required. Provide explanation.

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

Explanation:

The radionuclide reporting requirements for waste generators are identified in RHLLW disposal facility WAC, PLN-5446, Section 2.0. The radionuclide activity limits are based on the analyses provided in the facility PA (DOE/ID-11421) and ECAR-1559 "Evaluation of Facility Inventory and Radiological Consequences to Support RHLLW Disposal Facility Safety-Basis and NEPA Documentation." RHLLW WAC have minimum reporting requirements identified in PLN-5446 and requirements specifying radionuclides be identified as surface contamination (S), or activation contamination (A). Other generators that dispose of resins will designate those waste streams as resin contamination ®, but that is not applicable to the legacy waste discussed in this UDQE.

The following figure provides a diagram explaining the methodology used to determine the final radionuclide inventory for the legacy waste canisters from RSWF. Steps #1 through #6 below provide further details of the methodology.



Step #1: Decay the original SEALION radiological inventory (separated as activation and surface contamination) in respective files to applicable dose rate measurement date. Independent decay files are used to be able to distinguish the activation and surface contamination components.

Step #2: Combine the decayed activation and surface contamination radionuclide inventories into one source term file and obtain a calculated dose rate modeled in MicroShield.

Step #3: Utilizing the dose rate obtained in Step #2, a scaling factor is determined. This scaling factor is the ratio of the calculated dose rate from Step #2 and the actual measured dose rate obtained by RSWF operations in the field. The combined decayed activation and surface contamination inventories are scaled manually, rather than using the MicroShield source inference tool in order to maintain the separation of the activation and surface contamination radionuclide inventories. The activity level for each radionuclide determined in Step #2 is divided by the calculated scaling factor. The scaling factor is defined in the following equation.

$$Scaling\ Factor = \frac{Calculated\ Dose\ Rate\ \left(\frac{mR}{hr}\right)}{Measured\ Dose\ Rate\ \left(\frac{mR}{hr}\right)}$$

Step #4: MicroShield is used to verify the scaled radiological inventory produces a modeled dose rate that corresponds to the applicable measured dose rates.

Step #5: MicroShield is used to perform decay heat calculations using the final radiological inventory determined for each container.

Step #6: Create a RHINO input file for each container with the radionuclides separated by activation contamination (A) and surface contamination (S) types.

The waste characterization methodology of the RH-LLW legacy waste at MFC has been changed from using the maximum recorded on-contact dose rate to using the canister average dose rate (see Step #3 above). Scaling the radionuclide inventory using the highest dose rate resulted in very conservative activity data, which is not representative of the actual waste contents. The MicroShield model uses a volumetric cylinder with side shield. For this geometry, the MicroShield software calculates the dose rate assuming a homogenous source within the container. By using the maximum reported dose rate in the software, the radionuclide inventory throughout the entire canister is overestimated. Using the maximum recorded on-contact dose rate measurement on the canister was an approved waste characterization process and documented in previous ECARs to meet the requirements necessary to receive and dispose waste at RHLLW Disposal Facility. However, given this waste type and the nonhomogeneous distribution of the activity, and the associated dose rates throughout the canister, the methodology of using the maximum reported dose rate is overly conservative for its intended use. Scaling the radionuclide inventory based on the average measured dose rate provides a more representative source term for each canister (ECAR-5970). Currently there are no plans to revise the radionuclide inventory of the 42 previously emplaced legacy canisters that were characterized using the maximum dose rate. This decision may be revisited in the future.

The revised waste characterization methodology provides a more representative source term, meets RHLLW disposal facility WAC, is within the bounds of the PA and does not alter conditions of the DAS. Therefore, future characterization of the RH-LLW legacy waste at RSWF will use the average dose rate methodology described in ECAR-5970.

Jonathan Jacobson	Jonathan Jacobson	5/26/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	5/26/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	5/26/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Amy M. Cox	Amy M. Cox	2022.05.26
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	5/26/2022
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-060

Subject: Evaluation of 5 HFEF-5 Waste Canisters from RWSF (SN-104, SN-106, SN-142, OWC034, and OWC036) for Flagged PA Checks during RHINO Acceptance Testing

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:

Prior to shipment, details of each waste canister are entered into the Remote-Handled Low-Level Waste (RHLLW) Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Five legacy HFEF-5 waste canisters with unique identifiers (IDs) were submitted to RHINO for acceptance testing. These canisters have been stored at the Radioactive Scrap and Waste Facility (RSWF) and are designated legacy canisters because the waste was generated prior to 4/21/2015. Each of the canisters were flagged (did not pass) by RHINO for PA Checks 9 and 10. Canister SN-104 was also flagged for PA Check 11. Table 1 contains a summary of the canister checks that were flagged by RHINO. Each PA check that was flagged by RHINO is explained below.

Table 1. Summary of canister checks flagged by RHINO.

Canister ID	PA Checks 9 and 10	PA Check 11	PA Check 12	PA Check 13
SN-104	X	X		
SN-106	X			
SN-142	X			
OWC034	X			
OWC036	X			

X indicates the container or inventory did not pass the check.

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)

These checks are flagged if the cumulative inventory for the specific generator, canister type, and waste form exceeds the PA 20-year base-case inventory. The cumulative inventory includes the inventory of all placed canisters plus the proposed canister. The exceedance may be the result of the proposed canister inventory or it may be a result of previously placed canisters. PA Check 9 performs the check for all radionuclides in the PA base case inventory (see ECAR-3940, Table 8), and PA Check 10 performs the check for key radionuclides only. Key radionuclides are those that failed screening and were fully evaluated in the PA (see INL/EXT-18-45184, Table 18, column 7). Thus, any canister that is flagged by PA Check 10 will also be flagged by PA Check 9. The cumulative inventory of non-key radionuclides should be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out. The cumulative inventory of key radionuclides should be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA. This is checked by examining the increase in performance measures (see RHINO PA Check tab, Checks 1 through 8) if the canisters were to be placed at the facility.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)

This check is flagged if the key radionuclide inventory in the canister exceeds 10% of the PA 20-year base-case inventory for the particular generator, canister type and waste form (see INL/EXT-18-45184, Table 18, column 8). According to INL/EXT-18-45184 (2018), the inventory of any canister that causes or contributes to an exceedance of these threshold values must be reviewed according to RH-ADM-5214 (2021) to determine if the estimated inventory/activity is an anomalous occurrence or indicative of a change in waste generation rates, and is within the bounds of the approved PA.

Exceedance of a threshold value or action level that is flagged by RHINO does not indicate a 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: 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: Each canister was flagged by RHINO for one or more exceedances of a threshold value or action level. This does not indicate a canister is unacceptable for disposal but the canister 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. A UDQE is recommended to address these issues.

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	5/26/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Tim Arsenault	Timothy Arsenault	5/26/2022
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: See Explanation below

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

   Yes ☐ No ☒

   Comments: See Explanation below

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 contains an evaluation of the PA checks flagged by RHINO. Figure 1 contains RHINO output of the PA performance measures for all placed canisters as of 5/24/2022, prior to placement of any of the canisters evaluated in this UDQE. The details for PA Checks 9 and 10 near the bottom of the figure indicate the inventories of 11 radionuclides already exceeds the PA 20-year base-case inventories for surface contamination in HFEF-5 canisters in the HFEF vault array before any of the 5 canisters were considered for disposal. Because the PA 20-year base-inventories for the generator/canister/waste form were already exceeded prior to acceptance testing of the 5 proposed canisters, each canister was flagged. Inventories of other radionuclides may result in additional exceedances.

PA Results

No.	Acceptance	Performance Measure	Value	Limit	Units	Type	Run Date/Time
1	Yes	All Pathways Dose	4.7699E-005	1	mrem/yr	Compliance	5/24/2022 1:16:38 PM
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/24/2022 1:16:38 PM
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/24/2022 1:16:38 PM
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/24/2022 1:16:38 PM
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/24/2022 1:16:38 PM
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/24/2022 1:16:38 PM
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/24/2022 1:16:38 PM
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/24/2022 1:16:38 PM
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/24/2022 1:16:39 PM
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/24/2022 1:16:39 PM
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/24/2022 1:16:39 PM
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/24/2022 1:16:39 PM
7	Yes	Intruder	1.5245E-002	20	mrem/yr	Compliance	5/24/2022 1:16:39 PM
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/24/2022 1:16:39 PM
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/24/2022 1:16:39 PM
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/24/2022 1:16:39 PM

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

Nuclide	Form	Vault	Generator	Array	East/West	Amount (Ci)	Limit Inv (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1021E+000	1.3503E-002
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9435E+000	1.6513E+000

Figure 1. PA performance measures output screen from RHINO for all placed canisters prior to consideration of the 5 proposed canisters.

Figures 2 through 6 show the PA Check output screens from RHINO for waste canisters SN-104, SN-106, SN-142, OWC034 and OWC036. Each shows the cumulative inventory if the proposed canister were to be placed in the facility and the impacts on performance measures from placement. Examination of the figures shows canister SN-104 was the only canister that was flagged by RHINO during PA Check 11. However, because there are no details for PA Check 11 at the bottom of Figure 2 indicating why canister SN-104 was flagged, the canister was evaluated by hand against the criteria of PA Check 11. Table 2 contains the results of the evaluation. Only key radionuclides are listed because PA Check 11 is conducted only for key radionuclides.

Table 2. Check of flagged PA Check 11 by RHINO for canister SN-104.

Nuclide	Gen	Waste Form	Canister Type	PA 20-yr Base Case Inventory (Ci)	10% Canister Inventory Threshold (Ci)[a]	SN-104 Inventory (Ci)	Ratio of SN-104 Inventory to 10% Canister Threshold
Co-60	MFC	S	HFEF-5	7.9139E-01	7.9139E-02	2.1874E-03	2.76E-02
Cs-137	MFC	S	HFEF-5	3.3072E+00	3.3072E-01	1.8606E-01	5.63E-01
Np-237	MFC	S	HFEF-5	6.8565E-08	6.8565E-09	1.3975E-12	2.04E-04
Pu-239	MFC	S	HFEF-5	1.5644E-02	1.5644E-03	1.5289E-06	9.77E-04
Sr-90	MFC	S	HFEF-5	6.7841E+00	6.7841E-01	4.8063E-01	7.08E-01
U-235	MFC	S	HFEF-5	1.8102E-06	1.8102E-07	4.7372E-11	2.62E-04

a. Canister thresholds are set at 10% of the PA 20-year base-case inventories (see INL 2018).

Because the ratio of SN-104 key radionuclide inventories to 10% canister threshold values are less than 1 (see Table 2, last column), it was determined that PA Check 11 should not have been flagged by RHINO. An assessment of RHINO to determine the cause of the erroneous flag is being conducted, but for this UDQE, only PA Checks 9 and 10 will be evaluated for all canisters.

Canister Details SN-104

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.6135E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.2781E+000	1.3503E-002	1.7601E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	3.4598E+000	3.3072E+000	1.8606E-001
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	1.3975E-012
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7304E-006	2.0675E-017	1.6894E-009
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3299E-006	4.7750E-011	4.7365E-011
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3299E-006	1.8102E-006	4.7372E-011
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	4.4242E+000	1.6513E+000	4.8075E-001

Figure 2. PA Check output screen from RHINO for waste canister SN-104.

Canister Details SN-106

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5247E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1022E+000	1.3503E-002	1.6676E-005
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	1.3747E-012
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	1.6390E-013
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	4.5861E-015
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	4.5869E-015
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9435E+000	1.6513E+000	4.5315E-005

Figure 3. PA Check output screen from RHINO for waste canister SN-106.

Canister Details SN-142

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5245E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1022E+000	1.3503E-002	2.8308E-005
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	3.4830E-012
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	8.5809E-014
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	2.4000E-015
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	2.4004E-015
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9436E+000	1.6513E+000	7.7798E-005

Figure 4. PA Check output screen from RHINO for waste canister SN-142.

Canister Details OWC034

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	4.8275E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.8113E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.4288E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9957E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8759E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0919E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5463E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.2106E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1022E+000	1.3503E-002	3.6120E-005
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9436E+000	1.6513E+000	9.9621E-005

Figure 5. PA Check output screen from RHINO for waste canister OWC034.

Canister Details OWC036

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	4.8167E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.8051E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.4211E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9913E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8718E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0895E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5418E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.1885E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	Yes	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1021E+000	1.3503E-002	1.4610E-005
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9435E+000	1.6513E+000	4.0302E-005

Figure 6. PA Check output screen from RHINO for waste canister OWC036.

Table 3 contains a summary of the radionuclide inventories flagged by RHINO for PA Checks 9 and 10. The total inventories of all five proposed canisters (see Table 3, column 2) are the sum of the individual canister contributions from the last column of the bottom portions of Figures 2 through 6. Radionuclides highlighted light blue in Table 3 (Ba-137m, Pa-233, Th-231 and Y-90) were screened out during phase I of a three-phase screening process for the PA because their half-lives are less than one year. The inventory of these radionuclides will have no impact on the PA all-pathway dose and they do not require evaluation. Radionuclides highlighted light green in Table 3 (Pu-238, Pu-240, Pu-241, Pu-242, and U-238) are not listed in the inventories of any of the five proposed canisters. These radionuclide inventories were flagged because the cumulative inventories of each radionuclide exceeds the PA 20-year base-case inventories due to previous disposals. These radionuclides require no further evaluation because each canister does not add anything to the placed inventory. The remaining radionuclides (Cs-137, Np-237 and U-235) are discussed below.

Table 3. Summary of radionuclide inventories flagged by RHINO for PA Checks 9 and 10.

Nuclide	Total Inventory of 5 Proposed Canisters (Ci)	Cumulative Inventory of Placed Canisters in HFEF Vault Array (Ci)	Cumulative Inventory of Placed + 5 Proposed Canisters in HFEF Vault Array (Ci)	Percent Inventory Increase if 5 Proposed Canisters were Placed in HFEF Vault Array
Ba-137m[a]	1.76E-01	3.10E+00	3.28E+00	5.7%
Cs-137[c]	1.86E-01	3.27E+00	3.46E+00	5.7%
Np-237	6.26E-12	1.75E-06	1.75E-06	0.00036%
Pa-233[a]	1.69E-09	1.73E-06	1.73E-06	0.098%
Pu-238[b]	0.00E+00	5.38E-04	5.38E-04	0.0%
Pu-240[b]	0.00E+00	5.79E-04	5.79E-04	0.0%
Pu-241[b]	0.00E+00	4.34E-04	4.34E-04	0.0%
Pu-242[b]	0.00E+00	5.79E-08	5.79E-08	0.0%
Th-231[a]	4.74E-11	2.33E-06	2.33E-06	0.002%
U-235	4.74E-11	2.33E-06	2.33E-06	0.002%
U-238[b]	0.00E+00	1.24E-06	1.24E-06	0.0%
Y-90[a]	4.81E-01	3.94E+00	4.42E+00	12.2%

a. Half-life less than 1 year. Inventory has no impact on the PA all-pathway dose and requires no evaluation.
b. Radionuclide not listed in inventory of the 5 proposed canisters. Radionuclide flagged because inventory already exceeds PA 20-year base-case inventory.
c. Cs-137 only listed in inventory of canister SN-104.
Bold radionuclides are considered key radionuclides fully evaluated in the PA.

Cs-137
Cs-137 was only reported in one of the 5 proposed canisters (SN-104). This inventory was flagged because the Cs-137 inventory in canister SN-104 would be enough to cause the cumulative inventory to exceed the PA 20-year base-case inventory for this generator/canister/waste form. Although Cs-137 is a key radionuclide as a result of the intruder pathway analysis in the PA, it is not a groundwater pathway concern, and the percent increase of 5.7% (see Table 3, last column) is not enough to make it a groundwater pathway concern. The inventory of Cs-137 being considered is also not an intruder concern because it would have been flagged by RHINO during PA Check 13. Therefore, the Cs-137 in the proposed canisters is acceptable for disposal.

Np-237
The total inventory increase of Np-237 in the 5 proposed canisters is 0.00036% (see Table 3, last column). This indicates the amount of Np-237 in the 5 proposed canisters is very small and acceptable for disposal.

U-235
The total inventory increase of U-235 in the 5 proposed canisters is 0.002% (see Table 3, last column). This indicates the amount of U-235 in the 5 proposed canisters is very small and acceptable for disposal.

Performance Measures Evaluation
Although the percent increase of radionuclides flagged by RHINO is small (see Table 3) and appears to be acceptable, increases in performance measures were checked to be certain. Figures 2 through 6 show the increase in each performance measure for each of the proposed canisters. Table 4 contains a summary of the increases in performance measures if all 5 of the proposed canisters were placed in the facility. The percent increases after adding the 5 proposed canisters range from 0 to 8.42% (see Table 4, penultimate column) depending on the

performance measure and period (compliance or post-compliance). The increase in all pathway dose is 2.19%. While the percent increases may not seem insignificant, the increases as a percent of the limits is very small for each performance measure (see Table 4, last column). This is additional evidence that the canisters are acceptable for disposal.

Table 4. Summary of performance measures for the five proposed canisters.

Performance Measure (PM)	Period	Limit[a]	Units	PM Before Addition of 5 Proposed Canisters	PM After Addition of 5 Proposed Canisters	Percent Increase in PM from All 5 Proposed Canisters	PM as Percent of Limit After Addition of 5 Proposed Canisters
All Pathways Dose	Compliance	1	mrem/yr	4.770E-05	4.874E-05	2.19%	0.0049%
All Pathways Dose	Post Compliance	12.5	mrem/yr	2.778E-02	2.839E-02	2.19%	0.23%
Beta-Gamma DE	Compliance	0.16	mrem/yr	3.388E-05	3.462E-05	2.19%	0.022%
Beta-Gamma DE	Post Compliance	2.4	mrem/yr	1.972E-02	2.015E-02	2.18%	0.84%
Ra-226/228	Compliance	0.2	pCi/L	8.346E-33	8.346E-33	0.0%	0.0%
Ra-226/228	Post Compliance	2.5	pCi/L	7.798E-07	7.798E-07	0.0%	0.00003%
Gross Alpha	Compliance	0.6	pCi/L	1.809E-30	1.809E-30	0.0%	0.0%
Gross Alpha	Post Compliance	7.5	pCi/L	3.769E-06	3.769E-06	0.0%	0.00005%
Beta-Gamma ED	Compliance	0.16	mrem/yr	1.854E-05	1.894E-05	2.18%	0.012%
Beta-Gamma ED	Post Compliance	2	mrem/yr	1.079E-02	1.103E-02	2.19%	0.55%
Uranium	Compliance	1.2	ug/L	5.694E-28	5.694E-28	0.0%	0.0%
Uranium	Post Compliance	15	ug/L	1.080E-05	1.080E-05	0.0%	0.00007%
Intruder	Compliance	20	mrem/yr	1.525E-02	1.653E-02	8.42%	0.083%
Air Pathway	Compliance	0.4	mrem/yr	6.046E-07	6.353E-07	5.09%	0.00016%

a. Conservative limit in RHINO set to less than regulatory limit. In most cases the administrative limits are 1/25th the regulatory limits for the compliance period and one-half the regulatory limits for the post-compliance period.

Summary

The radionuclide inventories in canisters with unique IDs SN-104, SN-106, SN-142, OWC034, and OWC036 that were flagged by RHINO during PA checks have 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 5 proposed canisters are 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.

ECAR-3940, 2018, Baseline Radionuclide Inventory for the Remote-Handled Low-Level Waste Disposal Facility for Use in the Facility Performance Assessment, 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, 2017, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 1, Idaho National Laboratory, March 2018.

RH-ADM-5214, 2021, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Idaho National Laboratory, October 2021.

Jonathan Jacobson	Jonathan Jacobson	5/26/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	5/26/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	5/26/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Amy M. Cox	Amy M. Cox	2022.05.27
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	5/30/2022 ~~5/24/2022~~ TA 5/30/2022
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-061

Subject: Evaluation of 5 HFEF-5 Waste Canisters from RWSF (SN-130, SN-134, SN-148, SN-180, and MFC110124) for Flagged PA Checks during RHINO Acceptance Testing

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:

Prior to shipment, details of each waste canister are entered into the Remote-Handled Low-Level Waste (RHLLW) Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Five legacy HFEF-5 waste canisters with unique identifiers (IDs) were submitted to RHINO for acceptance testing. These canisters have been stored at the Radioactive Scrap and Waste Facility (RSWF) and are designated legacy canisters because the waste was generated prior to 4/21/2015. Each of the canisters were flagged (did not pass) by RHINO for PA Checks 9, 10, and 11. Canister SN-134 was also flagged for PA Check 13 and canister MFC110124 was flagged because it contains non-system radionuclides. Table 1 contains a summary of the canister checks that were flagged by RHINO. Each check is explained below.

Table 1. Summary of canister checks flagged by RHINO that require evaluation.

Canister ID	PA Checks 9 and 10[a]	PA Check 11[a]	PA Check 12[a]	PA Check 13[a]	Contains Non-System Radionuclides[b]
SN-130	X	X			
SN-134	X	X		X	
SN-148	X	X			
SN-180	X	X			
MFC110124	X	X			Yes

a. X indicates the container or inventory did not pass the check.
b. Yes indicates the container contains one or more non-system radionuclides.

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)
These checks are flagged if the cumulative inventory exceeds the PA 20-year base-case inventory for the specific generator, canister type, and waste form. The cumulative inventory includes the inventory of all placed canisters plus the proposed canister. The exceedance may be the result of the proposed canister inventory or it may be a result of previously placed canisters. PA Check 9 performs the check for all radionuclides in the PA base case inventory (see ECAR-3940, Table 8), and PA Check 10 performs the check for key radionuclides only. Key radionuclides are those that failed screening and were fully evaluated in the PA (see INL/EXT-18-45184, Table 18, column 7). Thus, any canister that is flagged by PA Check 10 will also be flagged by PA Check 9. The cumulative inventory of non-key radionuclides should be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out. The cumulative inventory of key radionuclides should be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA. This is checked by examining the increase in performance measures (see RHINO PA Check tab, Checks 1 through 8) if the canisters were to be placed at the facility.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)
This check is flagged if the key radionuclide inventory in the canister exceeds 10% of the PA 20-year base-case inventory for the particular generator, canister type and waste form (see INL/EXT-18-45184, Table 18, column 8). According to INL/EXT-18-45184 (2018), the inventory of any canister that causes or contributes to an exceedance of these threshold values must be reviewed according to RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility" to determine if the estimated

inventory/activity is an anomalous occurrence or indicative of a change in waste generation rates, and is within the bounds of the approved PA.

Exceedance of a threshold value or action level that is flagged by RHINO does not indicate a 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.

PA Check 12: Unanalyzed/Non-Exempt Nuclides Check

This flag is checked if the canister contains an unanalyzed radionuclide that is not on the exempt list. Unanalyzed radionuclides are radionuclides that were not considered during preparation of the PA. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214 (2021). All 5 proposed canisters passed this check, but the description is included for completeness.

PA Check 13: Canister Action Levels Check

This check is flagged if the canister contains a key radionuclide whose inventory exceeds canister action levels based on the chronic intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels are the array action levels (INL/EXT-18-45184, Table 20) divided by the total number of canisters that may be placed in the array. The canister action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters. According to PLN-5446 Section 2.3, action levels were established based on the chronic intruder[1] pathway scenario analyzed in the facility PA. If the radionuclide activity in a specific canister exceeds an action level, an evaluation must be conducted in accordance with RH-ADM-5214 (2021).

Identification of Non-System Radionuclide

Non-System radionuclides[2] are radionuclides that are not in the RHINO database and are similar to unanalyzed/non-exempt radionuclides (PA Check 12) in that they were not considered during preparation of the PA. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214 (2021). These radionuclides are identified on the "Nuclides" tab under the "Canister Details" page in RHINO. A future update of RHINO will include a check for non-system radionuclides on the "PA Check" tab.

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*

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[1] The chronic intruder scenario is the more limiting of the two intruder scenarios (acute, chronic) evaluated in the PA.

[2] Non-system radionuclides are currently identified on the Nuclides tab under the Canister Details page in RHINO, and are not listed on the PA Check tab. RHINO is being revised to include the check for non-system radionuclides on the PA Check tab.

*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: Each canister was flagged by RHINO for one or more exceedances of a threshold value or action level or because it contains non-system radionuclides that were not analyzed in the PA. This does not indicate the canisters are unacceptable for disposal but the canister 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 canisters may be approved for disposal. A UDQE is recommended to address these issues.

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	6/22/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault	6/22/2022
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: See Explanation below

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

Yes ☐ No ☒

Comments: See Explanation below

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 contains an evaluation of the PA checks flagged by RHINO for 5 proposed HFEF-5 canisters from RSWF with specific identifiers SN-130, SN-134, SN-148, SN-180, and MFC110124. Figure 1 contains RHINO output of the PA performance measures for all placed canisters as of 5/24/2022, prior to placement of the five canisters evaluated in this UDQE and prior to the five canisters evaluated in UDQE-RHLLW-060. The five canisters evaluated in UDQE-RHLLW-060 and the five canisters evaluated in this UDQE were screened for acceptance by RHINO at the same time. Although the five canisters evaluated in UDQE-RHLLW-060 will have been placed before the canisters evaluated in this UDQE will be placed, for this UDQE the information in Figure 1 will be considered to be unaffected by the five canisters evaluated in UDQE-RHLLW-060 because the impact is

insignificant with respect to any decisions that will be made regarding the five proposed canisters evaluated in this UDQE.

PA Results

No.	Acceptance	Performance Measure	Value	Limit	Units	Type	Run Date/Time
1	Yes	All Pathways Dose	4.7699E-005	1	mrem/yr	Compliance	5/24/2022 1:16:38 PM
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/24/2022 1:16:38 PM
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/24/2022 1:16:38 PM
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/24/2022 1:16:38 PM
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/24/2022 1:16:38 PM
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/24/2022 1:16:38 PM
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/24/2022 1:16:38 PM
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/24/2022 1:16:38 PM
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/24/2022 1:16:39 PM
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/24/2022 1:16:39 PM
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/24/2022 1:16:39 PM
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/24/2022 1:16:39 PM
7	Yes	Intruder	1.5245E-002	20	mrem/yr	Compliance	5/24/2022 1:16:39 PM
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/24/2022 1:16:39 PM
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/24/2022 1:16:39 PM
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/24/2022 1:16:39 PM

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

Nuclide	Form	Vault	Generator	Array	East/West	Amount (Ci)	Limit Inv (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1021E+000	1.3503E-002
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9435E+000	1.6513E+000

Figure 1. PA performance measures output screen from RHINO for all placed canisters prior to consideration of the 5 proposed canisters. Radionuclides listed at the bottom under PA checks 9 &10 exceed the PA base case inventory for this generator/canister/waste form prior to acceptance testing of the 5 proposed canisters.

Figures 2 through 6 show the PA Check output screens from RHINO for the 5 proposed waste canisters identified as SN-130, SN-134, SN-148, SN-180, and MFC110124. Each shows the cumulative inventory if the proposed canister were to be placed in the facility and the impacts on performance measures from placement. Examination of the figures shows each canister was flagged by RHINO during PA Checks 9, 10, and 11. Canister SN-134 was also flagged during PA Check 13. Additionally, Canister MFC110124 contains non-system radionuclides. Each of these flagged PA checks and the non-system radionuclides will be evaluated for impacts to the PA.

Some of the values in Figure 2 through 6 will be slightly different when the time comes for each can to be placed at the facility because the 5 canisters evaluated in UDQE-RHLLW-060 will have been placed and some of the canisters in this UDQE may have been placed in the facility. This will impact both the performance measures and the cumulative facility inventories of some radionuclides, but this is to be expected and does not affect any decisions made with regard to the acceptability of each canister.

Canister Details SN-130

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7692E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6936E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0804E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5245E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1022E+000	1.3503E-002	4.5350E-005
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	2.8784E-013
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	4.7262E-013
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	4.7750E-011	1.3218E-014
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3298E-006	1.8102E-006	1.3220E-014
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9436E+000	1.6513E+000	1.2457E-004

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)
Co-60	S	MFC	HFEF-5 Can	2	4.6450E-001	7.9139E-001	7.9139E-002

Figure 2. PA Check output screen from RHINO for waste canister SN-130.

Canister Details SN-134

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.6214E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	8.0541E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8691E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.8510E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.7727E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0953E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.8896E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0518E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	No	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.2117E+000	1.3503E-002	1.0955E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	3.3895E+000	3.3072E+000	1.1580E-001
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	3.9951E-008
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7725E-006	6.8565E-008	2.2800E-008
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.9357E-006	2.0675E-017	2.0702E-007
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	5.5791E-013	4.6793E-017	5.5791E-013
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004	5.8559E-004
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9496E-007	1.7684E-007	9.9496E-007
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.4987E-004	1.6411E-004	1.2304E-005
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7993E-004	6.1053E-005	7.7316E-007
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.4175E-004	3.0447E-004	7.4910E-006
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	2.8234E-012	4.1935E-016	2.8234E-012
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004	3.7328E-003
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6644E-015	6.5215E-008
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	5.8073E-010	2.1520E-013	5.8073E-010
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4195E-006	4.7750E-011	8.9712E-008
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4376E-007	1.0918E-005
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006	3.0687E-005
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4195E-006	1.8102E-006	8.9712E-008
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2525E-006	9.1146E-007	8.2989E-009
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	6.4583E+000	1.6513E+000	2.5148E+000

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)
I-129	S	MFC	HFEF-5 Can	2	3.9951E-008	4.4004E-009	4.4004E-010
Np-237	S	MFC	HFEF-5 Can	2	2.2800E-008	6.8565E-008	6.8565E-009
Sr-90	S	MFC	HFEF-5 Can	2	2.5142E+000	6.7841E+000	6.7841E-001

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Sr-90	HFEF-5 Can	2.5142E+000	6.9700E-001

Figure 3. PA Check output screen from RHINO for waste canister SN-134.

Canister Details SN-148

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	4.7699E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	2.7778E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.3879E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	1.9720E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.3462E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.7975E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8090E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7711E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	1.8536E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.0789E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.6939E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0825E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.6167E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0457E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.3310E+000	1.3503E-002	2.2890E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	3.5157E+000	3.3072E+000	2.4196E-001
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7499E-006	6.8565E-008	2.0854E-010
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7289E-006	2.0675E-017	1.6548E-010
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3299E-006	4.7750E-011	3.1024E-011
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3299E-006	1.8102E-006	3.1030E-011
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2442E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	4.4002E+000	1.6513E+000	4.5676E-001

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)
H-3	S	MFC	HFEF-5 Can	2	1.1483E-005	3.4893E-005	3.4893E-006
Pu-239	S	MFC	HFEF-5 Can	2	1.8149E-003	1.5644E-002	1.5644E-003

Figure 4. PA Check output screen from RHINO for waste canister SN-148.

Canister Details SN-180

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	5.3956E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	3.1421E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	3.8323E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	2.2306E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.6359E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	8.0680E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8679E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.8252E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	2.0967E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.2204E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.8012E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.1032E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	1.5352E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.0482E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1211E+000	1.3503E-002	1.8949E-002
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	9.0885E-014	4.6793E-017	9.0885E-014
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3757E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7916E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.3426E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.7892E-008	1.7066E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	8.1568E-013	4.1935E-016	8.1568E-013
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	3.2019E-010	2.1520E-013	3.2019E-010
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3482E-006	4.7750E-011	1.8379E-008
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3482E-006	1.8102E-006	1.8379E-008
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2715E-006	9.1146E-007	2.7316E-008
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9671E+000	1.6513E+000	2.3601E-002

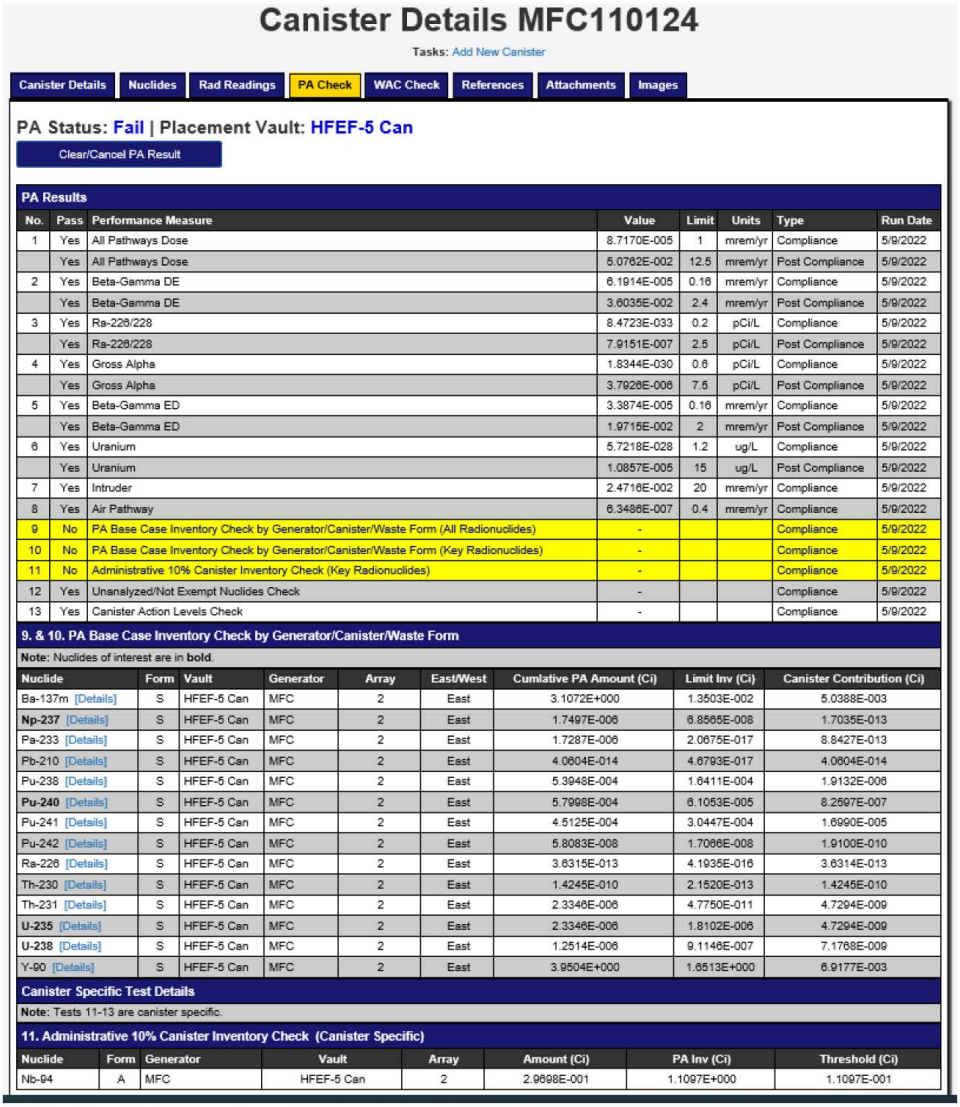
Canister Specific Test Details

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)
Pu-239	S	MFC	HFEF-5 Can	2	2.1793E-003	1.5644E-002	1.5644E-003

Figure 5. PA Check output screen from RHINO for waste canister SN-180.



Canister Details MFC110124

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	8.7170E-005	1	mrem/yr	Compliance	5/9/2022
	Yes	All Pathways Dose	5.0762E-002	12.5	mrem/yr	Post Compliance	5/9/2022
2	Yes	Beta-Gamma DE	6.1914E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma DE	3.6035E-002	2.4	mrem/yr	Post Compliance	5/9/2022
3	Yes	Ra-226/228	8.4723E-033	0.2	pCi/L	Compliance	5/9/2022
	Yes	Ra-226/228	7.9151E-007	2.5	pCi/L	Post Compliance	5/9/2022
4	Yes	Gross Alpha	1.8344E-030	0.6	pCi/L	Compliance	5/9/2022
	Yes	Gross Alpha	3.7926E-006	7.5	pCi/L	Post Compliance	5/9/2022
5	Yes	Beta-Gamma ED	3.3874E-005	0.16	mrem/yr	Compliance	5/9/2022
	Yes	Beta-Gamma ED	1.9715E-002	2	mrem/yr	Post Compliance	5/9/2022
6	Yes	Uranium	5.7218E-028	1.2	ug/L	Compliance	5/9/2022
	Yes	Uranium	1.0857E-005	15	ug/L	Post Compliance	5/9/2022
7	Yes	Intruder	2.4716E-002	20	mrem/yr	Compliance	5/9/2022
8	Yes	Air Pathway	6.3486E-007	0.4	mrem/yr	Compliance	5/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	5/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	5/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	5/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	5/9/2022
13	Yes	Canister Action Levels Check	-			Compliance	5/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.1072E+000	1.3503E-002	5.0388E-003
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7497E-006	6.8565E-008	1.7035E-013
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.7287E-006	2.0675E-017	8.8427E-013
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	4.0604E-014	4.6793E-017	4.0604E-014
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.3948E-004	1.6411E-004	1.9132E-008
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.7998E-004	6.1053E-005	8.2597E-007
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5125E-004	3.0447E-004	1.6990E-005
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-008	1.7066E-008	1.9100E-010
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	3.6315E-013	4.1935E-016	3.6314E-013
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.4245E-010	2.1520E-013	1.4245E-010
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.3346E-006	4.7750E-011	4.7294E-009
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.3346E-006	1.8102E-006	4.7294E-009
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2514E-006	9.1146E-007	7.1768E-009
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	3.9504E+000	1.6513E+000	6.9177E-003

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)
Nb-94	A	MFC	HFEF-5 Can	2	2.9698E-001	1.1097E+000	1.1097E-001

Figure 6. PA Check output screen from RHINO for waste canister MFC110124.

PA Checks 9 and 10

PA Checks 9 and 10 are flagged if the cumulative inventory for the specific generator, canister type, and waste form exceeds the PA 20-year base-case inventory. The cumulative inventory includes the inventory of all placed canisters plus the proposed canister(s). The exceedance may be the result of the proposed canister inventory or it may be a result of previously placed canisters. PA Check 9 performs the check for all radionuclides in the PA base case inventory (see ECAR-3940, Table 8), and PA Check 10 performs the check for key radionuclides only. Key

radionuclides are those that failed screening and were fully evaluated in the PA (see INL/EXT-18-45184, Table 18, column 7). Thus, any canister that is flagged by PA Check 10 will also be flagged by PA Check 9. The cumulative inventory of non-key radionuclides should be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out during preparation of the PA. The cumulative inventory of key radionuclides should be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA. This is checked by examining the increase in performance measures (see RHINO PA Check tab, Checks 1 through 8) if the canisters were to be placed at the facility.

The details for PA Checks 9 and 10 near the bottom of Figure 1 indicate the inventories of 11 radionuclides already exceed the PA 20-year base-case inventories for surface contamination in HFEF-5 canisters in the HFEF vault array even before the five proposed canisters in this UDQE will be disposed of. Because the PA 20-year base-case inventories for the generator/canister/waste form were already exceeded prior to acceptance testing of the 5 proposed canisters, each canister was flagged. Inventories of other radionuclides may result in additional exceedances.

For evaluation of PA Checks 9 and 10, the inventory of the 5 proposed canisters will be considered together. Table 2 contains a summary of the radionuclide inventories flagged by RHINO for PA Checks 9 and 10. The total inventories of all five proposed canisters (Table 2, column 3) are the sum of the individual canister contributions from the last column of the bottom portions of Figures 2 through 6. The cumulative inventory of these radionuclides in canisters already placed at the facility is shown in column 3. Column 4 contains the cumulative inventory if the 5 proposed canisters were placed at the facility which is the sum of columns 2 and 3. The final column shows the percent increase of each radionuclide for this generator/canister/waste form if the 5 proposed canisters were placed.

Radionuclides highlighted light blue in Table 2 (Ba-137m, Pa-233, Th-231 and Y-90, see footnote a) were screened out during phase I of a three-phase screening process for the PA because their half-lives are less than one year. According to the PA, the inventory of these radionuclides will have no impact on the PA all-pathway dose and therefore, they do not require further evaluation. Radionuclides shaded green (I-129, Pb-210, Pm-147, Pu-236, Ra-226, Sm-151, Th-229, Th-230, U-232, and U-233, see footnote b) were not listed in the inventory of any of the previously placed HFEF-5 canisters from MFC, nor in the 5 proposed canisters evaluated in UDQE-RHLLW-060 which are being placed at the time this UDQE is being prepared. This is why the cumulative inventory in placed canisters is zero in Table 2, column 4. The inventory of the non-shaded radionuclides (Cs-137, Np-237, Pu-238, Pu-240-, Pu-241, Pu-242, U-235 and U-238) would cause the cumulative inventory for this generator/canister/waste form to increase from 0.3% to 10.9% (Table 2, column 6) depending on the radionuclide. These increases seem small and within the bounds of the PA but further evaluation is recommended of both the green and non-shaded radionuclides. The key radionuclides will be evaluated to determine if the impact on performance measures in within the bounds of the PA, and non-key radionuclides will be evaluated to determine if the increased inventory would have caused the radionuclide to not be screened out during the PA screening process.

Table 2. Summary of radionuclide inventories flagged by RHINO for PA Checks 9 and 10.

1	2	3	4	5	6
Nuclide	Waste Form	Total Inventory of 5 Proposed Canisters (Ci)	Cumulative Inventory of Placed Canisters in HFEF Vault Array (Ci)	Cumulative Inventory of Placed + 5 Proposed Canisters in HFEF Vault Array (Ci)	Percent Inventory Increase if 5 Proposed Canisters were Placed in HFEF Vault Array
Ba-137m[a]	SC	3.62E-01	3.10E+00	3.46E+00	11.7%
Cs-137	SC	3.58E-01	3.27E+00	3.63E+00	10.9%
I-129[b]	SC	4.00E-08	0	4.00E-08	NA
Np-237	SC	2.30E-08	1.75E-06	1.77E-06	1.32%
Pa-233[a]	SC	2.07E-07	1.73E-06	1.94E-06	12.0%
Pb-210[b]	SC	6.89E-13	0	6.89E-13	NA
Pm-147[b]	SC	5.86E-04	0	5.86E-04	NA
Pu-236[b]	SC	9.95E-07	0	9.95E-07	NA
Pu-238	SC	1.42E-05	5.38E-04	5.52E-04	2.6%
Pu-240	SC	1.60E-06	5.79E-04	5.81E-04	0.3%
Pu-241	SC	2.45E-05	4.34E-04	4.59E-04	5.6%
Pu-242	SC	1.91E-10	5.79E-08	5.81E-08	0.3%
Ra-226[b]	SC	4.00E-12	0	4.00E-12	NA
Sm-151[b]	SC	3.73E-03	0	3.73E-03	NA
Th-229[b]	SC	6.52E-08	0	6.52E-08	NA
Th-230[b]	SC	1.04E-09	0	1.04E-09	NA
Th-231[a]	SC	1.13E-07	2.33E-06	2.44E-06	4.8%
U-232[b]	SC	1.09E-05	0	1.09E-05	NA
U-233[b]	SC	3.07E-05	0	3.07E-05	NA
U-235	SC	1.13E-07	2.33E-06	2.44E-06	4.8%
U-238	SC	4.28E-08	1.24E-06	1.29E-06	3.4%
Y-90[a]	SC	3.00E+00	3.94E+00	6.95E+00	76.1%

a. Half-life less than 1 year. Inventory has no impact on the PA all-pathway dose and requires no evaluation.
b. Radionuclide not listed in the inventory of all previously placed canisters, or proposed canisters evaluated in UDQE-RHLLW-060 currently being placed during preparation of this UDQE.
SC denotes surface contaminated debris waste form
Bold radionuclides are key radionuclides meaning they were not screened and were fully evaluated in the PA. Other radionuclides (non-key) were screened out during preparation of the PA.

Performance Measure Evaluation for PA Checks 9 and 10

Although the percent increase of radionuclides flagged by RHINO is small (see Table 2) and appears to be acceptable, increases in performance measures were checked to be certain. Figures 2 through 6 show the increase in each performance measure for each of the proposed canisters. Table 3 contains a summary of the increases in performance measures if all 5 of the proposed canisters were placed in the facility. The percent increases after adding the 5 proposed canisters range from 3.8% to 95.87% (see Table 3, column 7) depending on the performance measure and period (compliance or post-compliance). The increase in the all-pathway dose is 95.87% indicating the dose is approximately double after adding the 5 proposed canisters. While the percent increases are significant, the increases as a percent of the limits is very small for each performance measure (see Table 3, column 8). Additionally, the percent increase is based on the conservative administrative limits in RHINO (see Table 3, column 3) which for most measures are 1/25th the regulatory limit. This is additional evidence that the canisters are acceptable for disposal.

Table 3. Summary of performance measures for the five proposed canisters.

1	2	3	4	5	6	7	8
Performance Measure (PM)	Period	Limit[a]	Units	PM Before Addition of 5 Proposed Canisters	PM After Addition of 5 Proposed Canisters	Percent Increase in PM from All 5 Proposed Canisters	PM as Percent of Limit After Addition of 5 Proposed Canisters
All Pathways Dose	Compliance	1	mrem/yr	4.770E-05	9.343E-05	95.87%	0.0093%
All Pathways Dose	Post Compliance	12.5	mrem/yr	2.778E-02	5.441E-02	95.86%	0.44%
Beta-Gamma DE	Compliance	0.16	mrem/yr	3.388E-05	6.636E-05	95.87%	0.041%
Beta-Gamma DE	Post Compliance	2.4	mrem/yr	1.972E-02	3.862E-02	95.85%	1.61%
Ra-226/228	Compliance	0.2	pCi/L	8.346E-33	9.037E-33	8.3%	0.0%
Ra-226/228	Post Compliance	2.5	pCi/L	7.798E-07	8.442E-07	8.3%	0.00003%
Gross Alpha	Compliance	0.6	pCi/L	1.809E-30	1.953E-30	8.0%	0.0%
Gross Alpha	Post Compliance	7.5	pCi/L	3.769E-06	3.932E-06	4.3%	0.00005%
Beta-Gamma ED	Compliance	0.16	mrem/yr	1.854E-05	3.631E-05	95.86%	0.023%
Beta-Gamma ED	Post Compliance	2	mrem/yr	1.079E-02	2.113E-02	95.85%	1.06%
Uranium	Compliance	1.2	ug/L	5.694E-28	5.909E-28	3.8%	0.0%
Uranium	Post Compliance	15	ug/L	1.080E-05	1.126E-05	4.2%	0.00008%
Intruder	Compliance	20	mrem/yr	1.525E-02	2.940E-02	92.82%	0.147%
Air Pathway	Compliance	0.4	mrem/yr	6.046E-07	6.357E-07	5.15%	0.00016%

a. Conservative limit in RHINO set to less than regulatory limit. In most cases the administrative limits are 1/25th the regulatory limits for the compliance period and one-half the regulatory limits for the post-compliance period.

In addition to evaluating the impact on performance measures, the cumulative inventories of the radionuclides flagged by PA checks 9 and 10 were compared to 20-yr PA base case inventories. Table 4 compares the cumulative inventory of the flagged radionuclides in all placed canisters plus the 5 proposed canisters (column 2) to the PA 20-yr base case inventory for this generator/canister/waste form (MFC/HFEF-5/surface contaminated debris) (column 4) and the PA 20-yr base case inventory of surface contaminated debris for the entire RHLLW disposal facility (column 6). For Table 4, the radionuclides with half-lives less than one year have been removed, and the key radionuclides (shown in bold font) are shown separately from the non-key radionuclides. The cumulative inventory of all placed plus the 5 proposed canisters as a percentage of the PA 20-yr base case inventory for this generator/canister/waste form is shown in column 5. They are all greater than 100% which is why the radionuclides were flagged by RHINO, but some are much greater than 100%. For key radionuclides, the percentages of I-129 (908%), Np-237 (2584%) and Pu-240 (951%) are much greater than the PA 20-yr base case inventory for this generator/canister/waste form. In this case, the I-129 is solely a result of the inventory in one proposed canister (SN-134) as this is first HFEF-5 canister with I-129 listed in the inventory. The high percentages of Np-237 and Pu-240 are the result of previous disposals which can be seen by noting the values in column 2 are approximately 2 orders of magnitude less than column 3. Although the cumulative inventories of these three radionuclides are high compared to the 20-yr PA base case inventories for this generator/canister/waste form, the impact on the all-pathway dose is well within the bounds of the PA (see Table 3) and the cumulative inventory of the placed plus 5 proposed canisters is a relatively small percentage of the total facility PA base case inventory (see Table 4, column 7) for this waste form (surface contamination). Nevertheless, this shows that actual inventories for this generator/canister/waste form are greater than the base case inventory projections used for the PA. Therefore, it is again recommended the projected PA base case inventory estimate for this generator/canister/waste form be reevaluated similar to the recommendation made in UDQE-RHLLW-053.

Table 4. Radionuclide inventories flagged by RHINO for PA Checks 9 and 10 as a percent of the PA base case.

1	2	3	4	5	6	7
Nuclide[a]	Total Inventory of 5 Proposed HFEF-5 Canisters (Ci)[b]	Cumulative Inventory of All Placed + 5 Proposed HFEF-5 Canisters (Ci)[b]	PA 20-yr Base Case Inventory for MFC Legacy and Future Generation SC Debris in HFEF-5 Canisters (Ci)[b]	Cumulative Inventory of Placed + 5 Proposed Canisters as a Percent of the PA Base Case in HFEF-5 Canisters	Total Facility PA Base Case Inventory (Ci)[b]	Cumulative Inventory of Placed + 5 Proposed Canisters as a Percent of Total Facility 20-yr PA Base Case Inventory
Key Radionuclides (fully evaluated in PA, included in RHINO all-pathway dose calculation)						
Cs-137	3.58E-01	3.63E+00	3.31E+00	110%	9.18E+02	0.4%
I-129	4.00E-08	4.00E-08	4.40E-09	908%	5.05E-04	0.01%
Np-237	2.30E-08	1.77E-06	6.86E-08	2584%	5.82E-04	0.3%
Pu-240	1.60E-06	5.81E-04	6.11E-05	951%	2.28E-03	25%
U-235	1.13E-07	2.44E-06	1.81E-06	135%	3.70E-03	0.07%
U-238	4.28E-08	1.29E-06	9.12E-07	141%	7.41E-04	0.2%
Non-Key Radionuclides (screened out in PA, not included in RHINO all-pathway dose calculation)						
Pb-210	6.89E-13	6.89E-13	4.68E-17	1.4E+06%	2.89E-12	24%
Pm-147	5.86E-04	5.86E-04	1.08E-04	542%	2.78E-01	0.2%
Pu-236	9.95E-07	9.95E-07	1.77E-07	562%	1.77E-07	562%
Pu-238	1.42E-05	5.52E-04	1.64E-04	336%	3.55E-02	1.6%
Pu-241	2.45E-05	4.59E-04	3.04E-04	151%	2.07E-01	0.2%
Pu-242	1.91E-10	5.81E-08	1.71E-08	340%	1.22E-05	0.5%
Ra-226	4.00E-12	4.00E-12	4.19E-16	9.6E+05%	9.53E-12	42%
Sm-151	3.73E-03	3.73E-03	4.17E-04	895%	5.24E+01	0.01%
Th-229	6.52E-08	6.52E-08	1.66E-15	3.9E+09%	1.75E-15	3.7E+09%
Th-230	1.04E-09	1.04E-09	2.15E-13	4.9E+05%	1.26E-09	83%
U-232	1.09E-05	1.09E-05	3.44E-07	3174%	1.32E-04	8.3%
U-233	3.07E-05	3.07E-05	3.38E-06	908%	4.61E-06	666%

a. Does not include radionuclides from Table 2 with half-lives less than 1 year (Ba-137m, Pa-233, Th-231, Y-90).
b. All inventories are for surface contaminated debris.
Bold radionuclides are key radionuclides meaning they were not screened and were fully evaluated in the PA.

Non-Key Radionuclide Evaluation for PA Checks 9 and 10

For non-key radionuclides shown in Table 4, it is important to show that the cumulative inventory of the placed plus 5 proposed canisters would still have been screened out as it was during the PA. This was done by calculating the cumulative inventory of each radionuclide as a percent of the maximum allowable inventory allowed by the phase II and III screenings. For this calculation the inventory of the placed plus 5 proposed canisters 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 plus 5 projected 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 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:

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

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 5 shows that even when the projected cumulative inventory after placement of 5 proposed canisters (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 the 5 proposed canisters are within the bounds of the PA.

Table 5. 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	Total Inventory of 5 Proposed HFEF-5 Canisters (Ci)[a]	Projected Cumulative Inventory (Placed + 5 Proposed Cans) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of 5 Proposed Cans + Total PA Base Case Inventory (Col3+Col4) (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 5 Proposed Cans as % of Max Allowable Phase II Screening Inventory (Col5/Col7)
Pb-210	6.89E-13	6.89E-13	2.89E-12	3.58E-12	7.77E+04	5.15E-06	0.0001%
Pu-236	9.95E-07	9.95E-07[g]	6.92E-07	1.69E-06	5.55E+03	7.21E-05	2.3%
Ra-226	4.00E-12	4.00E-12	3.14E-11	3.54E-11	2.95E+05	1.36E-06	0.003%
Th-229	6.52E-08	6.52E-08[g]	5.35E-08	1.19E-07	1.18E+05	3.39E-06	3.5%
Th-230	1.04E-09	1.04E-09	4.93E-08	5.03E-08	1.59E+05	2.52E-06	2.0%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	Total Inventory of 5 Proposed HFEF-5 Canisters (Ci)[a]	Projected Cumulative Inventory (Placed + 5 Proposed Cans) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of 5 Proposed Cans + Total PA Base Case Inventory (Col3+Col4) (Ci)	PA Phase III Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Eqn 2) (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of 5 Proposed Cans as % of Max Allowable Phase III Screening Inventory (Col5/Col7)
Pm-147	5.86E-04	5.86E-04	5.23E+01	5.23E+01	1.00E-40	2.09E+41	<1E-40%
Pu-238	1.42E-05	5.52E-04	3.68E-01	3.69E-01	0.0257	5.73E+00	6.4%
Pu-241	2.45E-05	4.59E-04	1.97E+01	1.97E+01	0.0432	1.82E+02	11%
Pu-242	1.91E-10	5.81E-08	2.27E-04	2.27E-04	0.015	6.05E-03	3.8%
Sm-151	3.73E-03	3.73E-03	5.27E+01	5.27E+01	1.00E-40	2.11E+41	<1E-40%
U-232	1.09E-05	1.09E-05	2.31E-04	2.42E-04	0.000864	1.07E-01	0.2%
U-233	3.07E-05	3.07E-05	8.38E-05	1.14E-04	0.0254	1.32E-03	8.7%

a. Inventory of surface contaminated debris.
b. Table 2-14, RHLLW Performance Assessment (DOE/ID-11421).
c. Table 2-26, RHLLW Performance Assessment (DOE/ID-11421).
d. $Imax_{IIi}$ from Equation 1 above.
e. Table 2-26, RHLLW Performance Assessment (DOE/ID-11421).
f. $Imax_{IIIi}$ from Equation 2 above.
g. Inventory of placed plus 5 proposed canisters exceeds the total PA base case inventory.

PA Check 11

This check is flagged if the inventory of a key radionuclide in the canister exceeds 10% of the PA 20-year base-case inventory for the particular generator, canister type and waste form (see INL/EXT-18-45184, Table 18, column 8). When this occurs, the inventories greater than 10% must be reviewed to determine if: 1) they are anomalous or indicative of a change in waste generation rates, and 2) they are within the bounds of the approved PA.

All five canisters were flagged by RHINO during PA Check 11 for at least one radionuclide in each canister. Table 6 shows the canisters and radionuclides by waste form that were flagged during PA Check 11. Column 7 confirms the canister inventories are greater than 10% of the PA 20-yr base case inventories for the generator/canister/waste form. In fact, the I-129 inventory in canister SN-134 is nearly ten times the PA 20-yr base inventory (908%). Column 9 however shows the canister inventories are a very small percentage of the total RHLLW facility inventory for the particular waste form for all radionuclides except H-3. For H-3, the SN-148 canister inventory is 33% of the total RHLLW facility inventory for surface contamination. This is not very concerning though because the total facility inventory of H-3 (including resins and activated metals) is nearly 2000 Ci. Thus, based on the low percentages in Table 6, column 9, the inventories of the radionuclides flagged by PA Check 11 are within the bounds of the PA, but they do indicate some radionuclide inventories are greater than were projected for the PA for this generator and waste form. This is especially true for I-129 and somewhat for H-3. Because SN-134 is the first canister with I-129 listed in the inventory, it appears to be anomalous and not an indication of a change in generation rates. The same is true for the H-3 in canister SN-148.

Table 6. Summary of radionuclide inventories flagged by RHINO for PA Checks 9 and 10.

1	2	3	4	5	6	7	8	9
Can	Nuclide	Waste Form[a]	Canister Inventory (Ci)	PA 20-yr Base Case Inventory for MFC Legacy and Future Generation Waste in HFEF-5 Canisters for the Particular Waste Form (Ci)[b]	10% Threshold Inventory (Ci)[c]	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
SN-130	Co-60	SC	4.65E-01	7.91E-01	7.91E-02	59%	7.34E+02	0.1%
SN-134	I-129	SC	4.00E-08	4.40E-09	4.40E-10	908%	5.05E-04	0.01%
	Np-237	SC	2.28E-08	6.86E-08	6.86E-09	33%	5.82E-04	0.004%
	Sr-90	SC	2.51E+00	6.78E+00	6.78E-01	37%	6.42E+02	0.4%
SN-148	H-3	SC	1.15E-05	3.49E-05	3.49E-06	33%	3.49E-05	33%
	Pu-239	SC	1.81E-03	1.56E-02	1.56E-03	12%	3.15E-01	0.6%
SN-180	Pu-239	SC	2.18E-03	1.56E-02	1.56E-03	14%	3.15E-01	0.7%
MFC110124	Nb-94	AM	2.97E-01	1.11E+00	1.11E-01	27%	5.60E+01	0.5%

a. SC denotes surface contaminated debris waste form. AM denotes activated metal waste form.
b. From ECAR-3940, Table 16.
c. From INL/EXT-18-45184, Table 18, column 8.

PA Check 13

This check is flagged if the canister contains a key radionuclide whose inventory exceeds canister action levels based on the chronic intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters. According to the RHLLW WAC (PLN-5446 Section 2.3), action levels were established based on the chronic intruder[3] pathway scenario analyzed in the facility PA. If a specific canister exceeds the action levels, an evaluation must be conducted to ensure the inventory is within the bounds of the PA.

[3] The chronic intruder scenario is the more limiting of the two intruder scenarios (acute, chronic) evaluated in the PA.

Sr-90 in canister SN-134 was the only radionuclide inventory flagged by PA check 13. Table 7 shows the Sr-90 inventory in canister SN-134 is 361% of the canister action level (see Table 7, column 4) and 2% of the vault array action level (see Table 7, column 6). This level however is anomalous and is not indicative of other canisters. For example, the average Sr-90 inventory in the 5 canisters evaluated in this UDQE is 0.6 Ci/can. This is less than the canister action level for the HFEF vault array. Additionally, the total inventory of Sr-90 in all canisters placed in the HFEF vault array at the time this evaluation was being prepared is less than 4 Ci. This combined with the Sr-90 in canister SN-134 is approximately 6.5 Ci which is approximately 5.2% of the 125 Ci action level for the HFEF vault array (see Table 7, column 5). Given the HFEF vault array is filled to approximately 30% of capacity at the time of this evaluation, the amount of Sr-90 in canister SN-134 is within the bounds of the PA.

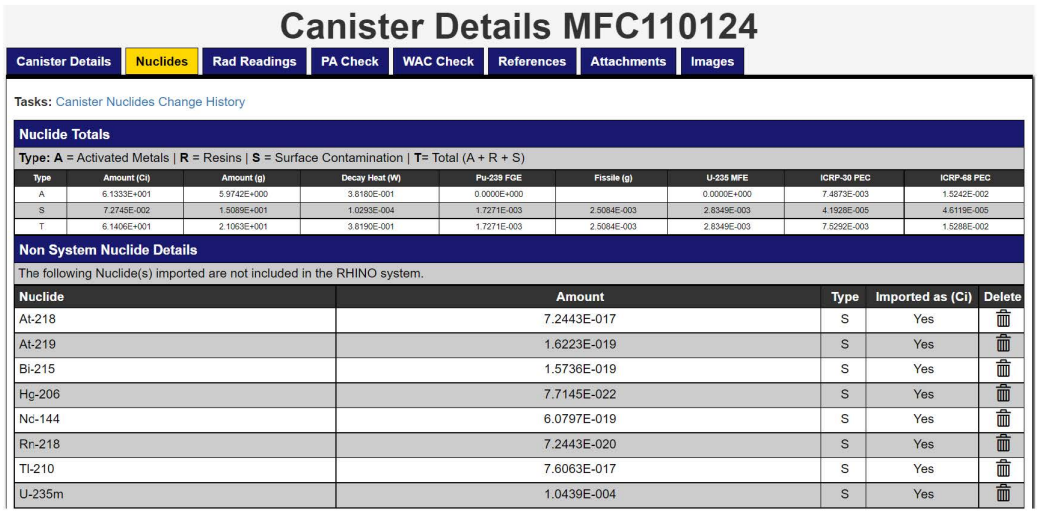
Table 7. Details of Sr-90 inventory evaluation for PA check 13.

1	2	3	4	5	6
Nuclide	Canister Inventory (Ci)	Canister Action Level for HFEF Vault Array (Ci)	Canister Inventory as % of Canister Action Level for HFEF Vault Array	Vault Array Action Level for HFEF Vault Array (Ci)	Canister Inventory as % of Vault Array Action Level for HFEF Vault Array
Sr-90	2.51E+00	6.97E-01	361%	125	2.0%

Check of Non-System Radionuclides

Non-System radionuclides are radionuclides that are not in the RHINO database and are similar to unanalyzed/non-exempt radionuclides (PA Check 12) in that they were not considered during preparation of the PA. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214 (2021). These radionuclides are identified on the "Nuclides" tab under the "Canister Details" page in RHINO.

Canister MFC110124 was the only canister of the 5 proposed canisters to contain non-system radionuclides. Figure 7 shows the output from the Nuclides output screen from RHINO for canister MFC110124 showing the non-system radionuclides included in the canister inventory.



Canister Details MFC110124

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

Tasks: Canister Nuclides Change History

Nuclide Totals

Type: A = Activated Metals | R = Resins | S = Surface Contamination | T= Total (A + R + S)

Type	Amount (Ci)	Amount (g)	Decay Heat (W)	Pu-239 FGE	Fissile (g)	U-235 MFE	ICRP-30 PEC	ICRP-68 PEC
A	6.1333E+001	5.9742E+000	3.8160E-001	0.0000E+000		0.0000E+000	7.4873E-003	1.5242E-002
S	7.2745E-002	1.5089E+001	1.0293E-004	1.7271E-003	2.5084E-003	2.8349E-003	4.1928E-005	4.6119E-005
T	6.1406E+001	2.1063E+001	3.6190E-001	1.7271E-003	2.5084E-003	2.8349E-003	7.5292E-003	1.5288E-002

Non System Nuclide Details

The following Nuclide(s) imported are not included in the RHINO system.

Nuclide	Amount	Type	Imported as (Ci)	Delete
At-218	7.2443E-017	S	Yes	
At-219	1.6223E-019	S	Yes	
Bi-215	1.5736E-019	S	Yes	
Hg-206	7.7145E-022	S	Yes	
Nd-144	6.0797E-019	S	Yes	
Rn-218	7.2443E-020	S	Yes	
Tl-210	7.6063E-017	S	Yes	
U-235m	1.0439E-004	S	Yes	

Figure 7. Nuclides output screen from RHINO for waste canister MFC110124 showing non-system radionuclides.

With the exception of U-235m, the radionuclide inventories in Figure 7 are all quite low (< 1E-16 Ci) and would likely have no impact on the PA based on inventory. Table 8 shows the half-lives of each of the non-system radionuclides in canister MFC110124 identified by RHINO. These radionuclides are likely not in the RHINO system database because they have very short half-lives, or in the case of Nd-144, are essentially stable. Radionuclides with half-lives less than one year or are essentially stable will have no impact on the all-pathway dose and no impact to the PA.

Table 8. Half-lives of non-system radionuclides in canister MFC110124 identified by RHINO.

Radionuclide	Half-life (yr)
At-218	4.8E-08
At-219	1.8E-06
Bi-215	1.4E-05
Hg-206	1.5E-05
Nd-144	2.3E+15[a]
Rn-218	1.1E-09
Tl-210	2.5E-06
U-235m	4.9E-05

a. Radionuclide is essentially stable.

Summary

The radionuclide inventories in canisters with unique identifiers SN-130, SN-134, SN-148, SN-180, and MFC110124 that were flagged by RHINO during PA checks have 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 5 proposed canisters are deemed acceptable for disposal.

This evaluation determined that actual inventories of some radionuclides for this generator/canister/waste form are greater than the base case inventory projections used for the PA. Therefore, it is again recommended the projected PA base case inventory estimate for this generator/canister/waste form be reevaluated similar to the recommendation made in UDQE-RHLLW-053.

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.

ECAR-3940, 2018, Baseline Radionuclide Inventory for the Remote-Handled Low-Level Waste Disposal Facility for Use in the Facility Performance Assessment, 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, 2017, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 1, Idaho National Laboratory, March 2018.

RH-ADM-5214, 2021, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Idaho National Laboratory, October 2021.

UDQE-RHLLW-053, 2022, "RHINO Acceptance Check of Canister MFC210277, Flagged PA and WAC Checks and Identification of Non-System Radionuclide," December 2021.

UDQE-RHLLW-060, 2022, "Evaluation of 5 HFEF-5 Waste Canisters from RWSF (SN-104, SN-106, SN-142, OWC034, and OWC036) for Flagged PA Checks during RHINO Acceptance Testing," May 2022.

Jonathan Jacobson	Jonathan Jacobson	6/22/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R. Prather	6/22/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeffrey Sondrup	Jeff Sondrup	06/22/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Amy M. Cox	Amy M. Cox	2022.06.22
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Timothy Arsenault	Timothy Arsenault	6/22/2022
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

UDQE Tracking No.: UDQE-RHLLW-062

Subject: Evaluation of 3 HFEF-5 Waste Canisters from RWSF (SN81, SN-107, and SN-139) Flagged for PA and WAC Checks during RHINO Acceptance Testing

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:

Prior to shipment, details of each waste canister are entered into the Remote-Handled Low-Level Waste (RHLLW) Inventory Online (RHINO[1]) software which performs several checks to evaluate the canister for acceptance. Three legacy HFEF-5 waste canisters with unique identifiers (IDs) were submitted to RHINO for acceptance testing. These canisters have been stored at the Radioactive Scrap and Waste Facility (RSWF) and are designated legacy canisters because the waste was generated prior to 4/21/2015. Each of the canisters were flagged (did not pass) by RHINO for PA Checks 9, 10, 11 and 13. Two of the three canisters (SN81 and SN-139) were also flagged by RHINO for having radionuclide inventories that exceed WAC check limits based on nuclear safety considerations. Table 1 contains a summary of the canister checks that were flagged by RHINO. Each check is explained below.

Table 1. Summary of canister checks flagged by RHINO that require evaluation.

Canister ID	Waste Content[a]	PA Checks 9 and 10[b]	PA Check 11[b]	PA Check 12[b]	PA Check 13[b]	Contains Non-System Radionuclides[c]	WAC Check
SN81	SC	X	X		X		X
SN-107	SC	X	X		X		
SN-139	Combined	X	X		X		X

a. SC = surface contaminated debris. Combined = activated metals and surface contaminated debris.
b. "X" indicates the canister inventory did not pass the check. A blank cell indicates it passed.
c. "Yes" indicates the container contains one or more non-system radionuclides.

PA Check 9: PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)
PA Check 10: PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides Only)

These checks are flagged if the cumulative inventory exceeds the PA 20-year base-case inventory for the specific generator, canister type, and waste form. The cumulative inventory includes the inventory of all placed canisters plus the proposed canister. The exceedance may be the result of the proposed canister inventory or it may be a result of previously placed canisters. PA Check 9 performs the check for all radionuclides in the PA base case inventory (see ECAR-3940, Table 8), and PA Check 10 performs the check for key radionuclides only. Key radionuclides are those that failed the PA screening and were fully evaluated in the PA (see INL 2018, Table 18, column 7). Thus, any canister that is flagged by PA Check 10 will also be flagged by PA Check 9. The cumulative inventory of non-key radionuclides should be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out. The cumulative inventory of key radionuclides should be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA. This is checked by examining the increase in performance measures (see RHINO PA Check tab, Checks 1 through 8) if the canisters were to be placed at the facility. All three of the proposed canisters were flagged by both these checks.

PA Check 11: Administrative 10% Canister Inventory Check (Key Radionuclides Only)

[1] RHINO 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 Handle-LLW Inventory Online Database."

This check is flagged if the key radionuclide inventory in the canister exceeds 10% of the PA 20-year base-case inventory for the particular generator, canister type and waste form (see INL 2018, Table 18, column 8). According to INL (2018), the inventory of any canister that causes or contributes to an exceedance of these threshold values must be reviewed according to RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility" to determine if the estimated inventory/activity is an anomalous occurrence or indicative of a change in waste generation rates, and is within the bounds of the approved PA. All three of the proposed canisters were flagged by this check.

PA Check 12: Unanalyzed/Non-Exempt Nuclides Check

This flag is checked if the canister contains an unanalyzed radionuclide that is not on the exempt list. Unanalyzed radionuclides are radionuclides that were not considered during preparation of the PA. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214 (2021). All three of the proposed canisters passed this check, but the description is included for completeness.

PA Check 13: Canister Action Levels Check

This check is flagged if the canister contains a key radionuclide whose inventory exceeds canister action levels based on the chronic intruder pathway dose standard (see INL 2018, Table 19). The canister action levels are the array action levels (INL 2018, Table 20) divided by the total number of canisters that may be placed in the array. The canister action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters. According to PLN-5446 Section 2.3, action levels were established based on the chronic intruder[2] pathway scenario analyzed in the facility PA. If the radionuclide activity in a specific canister exceeds an action level, an evaluation must be conducted in accordance with RH-ADM-5214 (2021). All three of the proposed canisters were flagged by this check.

Identification of Non-System Radionuclide

Non-System radionuclides[3] are radionuclides that are not in the RHINO database and are similar to unanalyzed/non-exempt radionuclides (PA Check 12) in that they were not considered during preparation of the PA. According to the WAC (PLN-5446), containers with reportable radionuclides not analyzed in the PA (see WAC, Tables B-1 through B-8), or not listed as an exempt radionuclide (see WAC, Table 1) will not be accepted for disposal at the RHLLW Disposal Facility without additional evaluation per RH-ADM-5214 (2021). These radionuclides are identified on the "Nuclides" tab under the "Canister Details" page in RHINO. A future update of RHINO will include a check for non-system radionuclides on the "PA Check" tab. All three of the proposed canisters passed this check, but the description is included for completeness.

WAC Check: WAC Nuclear Safety Limits

This flag is checked if the canister contains a radionuclide whose inventory exceeds nuclear-safety threshold levels derived in ECAR-1559 and presented in the WAC (PLN-5446). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the threshold levels adopted as waste acceptance criteria. If the canister inventory for one or more radionuclides exceeds threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values for that waste stream/canister combination. Two of the three proposed canisters were flagged by this check.

Exceedance of a threshold value or action level that is 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

[2] The chronic intruder scenario is the more limiting of the two intruder scenarios (acute, chronic) evaluated in the PA.

[3] Non-system radionuclides are currently identified on the Nuclides tab under the Canister Details page in RHINO, and are not listed on the PA Check tab. RHINO is being revised to include the check for non-system radionuclides on the PA Check tab.

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: Each canister was flagged by RHINO for one or more exceedances of a threshold value or action level. This does not indicate the canisters are unacceptable for disposal but the canister 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 canisters may be approved for disposal. A UDQE (see Section II) is recommended to address these issues.

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	8/24/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault	08/24/2022
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: See Explanation below

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

Yes ☐ No ☒

Comments: See Explanation below

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

An evaluation was performed for checks flagged by RHINO for three proposed legacy HFEF-5 waste canisters with specific identifiers SN81, SN-107, and SN-139. Each of the canisters were flagged (did not pass) by RHINO for performance assessment (PA) Checks 9, 10, 11 and 13, and two of the three canisters (SN81 and SN-139) were flagged by RHINO for having radionuclide inventories that exceed waste acceptance criteria (WAC) (PLN-5446) limits based on nuclear safety considerations. Table 1 contains a summary of the canister checks that were flagged by RHINO. Each check is evaluated in order.

Table 1. Summary of canister checks flagged by RHINO that require evaluation.

Canister ID	Waste Content[a]	PA Checks 9 and 10[b]	PA Check 11[b]	PA Check 12[b]	PA Check 13[b]	Contains Non-System Radionuclides[c]	WAC Check
SN81	SC	X	X		X		X
SN-107	SC	X	X		X		
SN-139	Combined	X	X		X		X

a. SC = surface contaminated debris. Combined = activated metals and surface contaminated debris.
b. "X" indicates the canister inventory did not pass the check. A blank cell indicates it passed.
c. "Yes" indicates the container contains one or more non-system radionuclides.

Exceedance of a threshold value or action level that is flagged by RHINO does not indicate a proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed in accordance with RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility." 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.

Figure 1 contains RHINO output showing the PA performance measures for all placed canisters as of 8/17/2022, prior to placement of the three canisters evaluated in this UDQE. Figures 2 through 4 show the PA Check output screens from RHINO for the three proposed waste canisters identified as SN81, SN-107, and SN-139. The performance measure values and cumulative inventories in Figures 2 through 4 reflect all containers placed and approved on 8/9/22 which includes all containers placed as of 8/17/22, plus the proposed canister. Thus the impact of each individual canister on performance measures can be determined by comparing the values in Figures 2 through 4 to the values in Figure 1.

PA Results

No.	Acceptance	Performance Measure	Value	Limit	Units	Type	Run Date/Time
1	Yes	All Pathways Dose	9.4471E-005	1	mrem/yr	Compliance	8/17/2022 11:59:28 AM
	Yes	All Pathways Dose	5.5013E-002	12.5	mrem/yr	Post Compliance	8/17/2022 11:59:28 AM
2	Yes	Beta-Gamma DE	6.7099E-005	0.16	mrem/yr	Compliance	8/17/2022 11:59:28 AM
	Yes	Beta-Gamma DE	3.9053E-002	2.4	mrem/yr	Post Compliance	8/17/2022 11:59:28 AM
3	Yes	Ra-226/228	9.0372E-033	0.2	pCi/L	Compliance	8/17/2022 11:59:28 AM
	Yes	Ra-226/228	8.4423E-007	2.5	pCi/L	Post Compliance	8/17/2022 11:59:28 AM
4	Yes	Gross Alpha	1.9535E-030	0.6	pCi/L	Compliance	8/17/2022 11:59:29 AM
	Yes	Gross Alpha	3.9323E-006	7.5	pCi/L	Post Compliance	8/17/2022 11:59:29 AM
5	Yes	Beta-Gamma ED	3.6711E-005	0.16	mrem/yr	Compliance	8/17/2022 11:59:29 AM
	Yes	Beta-Gamma ED	2.1367E-002	2	mrem/yr	Post Compliance	8/17/2022 11:59:29 AM
6	Yes	Uranium	5.9089E-028	1.2	ug/L	Compliance	8/17/2022 11:59:29 AM
	Yes	Uranium	1.1256E-005	15	ug/L	Post Compliance	8/17/2022 11:59:29 AM
7	Yes	Intruder	3.0683E-002	20	mrem/yr	Compliance	8/17/2022 11:59:29 AM
8	Yes	Air Pathway	6.6648E-007	0.4	mrem/yr	Compliance	8/17/2022 11:59:29 AM
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	8/17/2022 11:59:29 AM
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	8/17/2022 11:59:29 AM

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

Nuclide	Form	Vault	Generator	Array	East/West	Amount (Ci)	Limit Inv (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	3.6407E+000	1.3503E-002
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	3.8430E+000	3.3072E+000
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7727E-006	6.8565E-008
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.9376E-006	2.0675E-017
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	6.8940E-013	4.6793E-017
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9496E-007	1.7684E-007
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.5179E-004	1.6411E-004
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.8076E-004	6.1053E-005
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5874E-004	3.0447E-004
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-008	1.7066E-008
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	4.0022E-012	4.1935E-016
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004
Sr-90 [Details]	S	HFEF-5 Can	MFC	2	East	7.4568E+000	6.7841E+000
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6644E-015
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.0434E-009	2.1520E-013
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4427E-006	4.7750E-011
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4376E-007
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4427E-006	1.8102E-006
U-236 [Details]	S	HFEF-5 Can	MFC	2	East	2.3698E-006	2.3053E-006
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2870E-006	9.1146E-007
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	7.4267E+000	1.6513E+000

Figure 1. RHINO PA performance measures output screen for all placed canisters as of 8/17/2022. Radionuclides listed at the bottom under PA checks 9 &10 exceed the PA base case inventory for this generator/canister/waste form prior to acceptance testing of the three proposed canisters evaluated in this UDQE.

Canister Details SN81

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	9.4471E-005	1	mrem/yr	Compliance	8/9/2022
	Yes	All Pathways Dose	5.5013E-002	12.5	mrem/yr	Post Compliance	8/9/2022
2	Yes	Beta-Gamma DE	6.7099E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma DE	3.9053E-002	2.4	mrem/yr	Post Compliance	8/9/2022
3	Yes	Ra-226/228	9.0372E-033	0.2	pCi/L	Compliance	8/9/2022
	Yes	Ra-226/228	8.4423E-007	2.5	pCi/L	Post Compliance	8/9/2022
4	Yes	Gross Alpha	1.9554E-030	0.6	pCi/L	Compliance	8/9/2022
	Yes	Gross Alpha	3.9342E-006	7.5	pCi/L	Post Compliance	8/9/2022
5	Yes	Beta-Gamma ED	3.6711E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma ED	2.1367E-002	2	mrem/yr	Post Compliance	8/9/2022
6	Yes	Uranium	5.9282E-028	1.2	ug/L	Compliance	8/9/2022
	Yes	Uranium	1.1299E-005	15	ug/L	Post Compliance	8/9/2022
7	Yes	Intruder	3.2533E-002	20	mrem/yr	Compliance	8/9/2022
8	Yes	Air Pathway	6.6648E-007	0.4	mrem/yr	Compliance	8/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	8/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	8/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	8/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	8/9/2022
13	No	Canister Action Levels Check	-			Compliance	8/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumulative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	4.7263E+000	1.3503E-002	1.0856E+000
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	4.9906E+000	3.3072E+000	1.1476E+000
Eu-154 [Details]	S	HFEF-5 Can	MFC	2	East	8.9522E-003	8.7567E-003	7.2840E-003
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7727E-006	6.8565E-008	5.5120E-011
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	2.0617E-006	2.0675E-017	1.2408E-007
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	6.8940E-013	4.6793E-017	
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004	
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9496E-007	1.7684E-007	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.5179E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.8076E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5874E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-008	1.7066E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	4.0022E-012	4.1935E-016	
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004	
Sr-90 [Details]	S	HFEF-5 Can	MFC	2	East	7.8178E+000	6.7841E+000	3.6105E-001
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6644E-015	6.3135E-015
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.0434E-009	2.1520E-013	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4775E-006	4.7750E-011	3.4810E-008
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4376E-007	
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006	7.3760E-012
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4775E-006	1.8102E-006	3.4817E-008
U-236 [Details]	S	HFEF-5 Can	MFC	2	East	2.3698E-006	2.3053E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2870E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	7.7879E+000	1.6513E+000	3.6114E-001

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	MFC	HFEF-5 Can	2	1.1476E+000	3.3072E+000	3.3072E-001

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Cs-137	HFEF-5 Can	1.1476E+000	3.4000E-001

Figure 2. PA Check output screen from RHINO for waste canister SN81

Canister Details SN-107

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	9.4471E-005	1	mrem/yr	Compliance	8/9/2022
	Yes	All Pathways Dose	5.5013E-002	12.5	mrem/yr	Post Compliance	8/9/2022
2	Yes	Beta-Gamma DE	6.7099E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma DE	3.9053E-002	2.4	mrem/yr	Post Compliance	8/9/2022
3	Yes	Ra-226/228	9.0372E-033	0.2	pCi/L	Compliance	8/9/2022
	Yes	Ra-226/228	8.4423E-007	2.5	pCi/L	Post Compliance	8/9/2022
4	Yes	Gross Alpha	1.9535E-030	0.6	pCi/L	Compliance	8/9/2022
	Yes	Gross Alpha	3.9324E-006	7.5	pCi/L	Post Compliance	8/9/2022
5	Yes	Beta-Gamma ED	3.6711E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma ED	2.1367E-002	2	mrem/yr	Post Compliance	8/9/2022
6	Yes	Uranium	5.9089E-028	1.2	ug/L	Compliance	8/9/2022
	Yes	Uranium	1.1256E-005	15	ug/L	Post Compliance	8/9/2022
7	Yes	Intruder	3.4598E-002	20	mrem/yr	Compliance	8/9/2022
8	Yes	Air Pathway	6.6648E-007	0.4	mrem/yr	Compliance	8/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	8/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	8/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	8/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	8/9/2022
13	No	Canister Action Levels Check	-			Compliance	8/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	4.4124E+000	1.3503E-002	7.7169E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	4.6588E+000	3.3072E+000	8.1574E-001
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.7727E-006	6.8565E-008	3.1407E-011
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.9376E-006	2.0675E-017	4.1187E-011
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	6.8940E-013	4.6793E-017	
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004	
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9496E-007	1.7684E-007	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.5179E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.8076E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5874E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-008	1.7066E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	4.0022E-012	4.1935E-016	
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004	
Sr-90 [Details]	S	HFEF-5 Can	MFC	2	East	9.5727E+000	6.7841E+000	2.1159E+000
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6644E-015	1.5987E-018
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.0434E-009	2.1520E-013	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4427E-006	4.7750E-011	2.0868E-014
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4376E-007	
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006	2.1378E-015
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4427E-006	1.8102E-006	2.0872E-014
U-236 [Details]	S	HFEF-5 Can	MFC	2	East	2.3698E-006	2.3053E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2870E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	9.5431E+000	1.6513E+000	2.1164E+000

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	MFC	HFEF-5 Can	2	8.1574E-001	3.3072E+000	3.3072E-001
Sr-90	S	MFC	HFEF-5 Can	2	2.1159E+000	6.7841E+000	6.7841E-001

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Cs-137	HFEF-5 Can	8.1574E-001	3.4000E-001
Sr-90	HFEF-5 Can	2.1159E+000	6.9700E-001

Figure 3. PA Check output screen from RHINO for waste canister SN-107.

Canister Details SN-139

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	9.4471E-005	1	mrem/yr	Compliance	8/9/2022
	Yes	All Pathways Dose	5.5013E-002	12.5	mrem/yr	Post Compliance	8/9/2022
2	Yes	Beta-Gamma DE	6.7099E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma DE	3.9053E-002	2.4	mrem/yr	Post Compliance	8/9/2022
3	Yes	Ra-226/228	9.0372E-033	0.2	pCi/L	Compliance	8/9/2022
	Yes	Ra-226/228	8.4423E-007	2.5	pCi/L	Post Compliance	8/9/2022
4	Yes	Gross Alpha	1.9537E-030	0.6	pCi/L	Compliance	8/9/2022
	Yes	Gross Alpha	3.9685E-006	7.5	pCi/L	Post Compliance	8/9/2022
5	Yes	Beta-Gamma ED	3.6711E-005	0.16	mrem/yr	Compliance	8/9/2022
	Yes	Beta-Gamma ED	2.1367E-002	2	mrem/yr	Post Compliance	8/9/2022
6	Yes	Uranium	5.9094E-028	1.2	ug/L	Compliance	8/9/2022
	Yes	Uranium	1.1287E-005	15	ug/L	Post Compliance	8/9/2022
7	Yes	Intruder	3.2493E-002	20	mrem/yr	Compliance	8/9/2022
8	Yes	Air Pathway	6.6648E-007	0.4	mrem/yr	Compliance	8/9/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	8/9/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	8/9/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	8/9/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	8/9/2022
13	No	Canister Action Levels Check	-			Compliance	8/9/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

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

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	4.0612E+000	1.3503E-002	4.2052E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	4.2876E+000	3.3072E+000	4.4453E-001
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.8003E-006	6.8565E-008	2.7628E-008
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	1.9689E-006	2.0675E-017	3.1290E-008
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	6.8940E-013	4.6793E-017	
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004	
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9496E-007	1.7684E-007	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.5179E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.8076E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5874E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-008	1.7066E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	4.0022E-012	4.1935E-016	
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004	
Sr-90 [Details]	S	HFEF-5 Can	MFC	2	East	8.3789E+000	6.7841E+000	9.2211E-001
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6644E-015	1.0616E-015
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.0434E-009	2.1520E-013	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4428E-006	4.7750E-011	6.5389E-011
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4376E-007	
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006	1.5183E-012
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4428E-006	1.8102E-006	6.5402E-011
U-236 [Details]	S	HFEF-5 Can	MFC	2	East	2.3698E-006	2.3053E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2870E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	8.3491E+000	1.6513E+000	9.2235E-001

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	MFC	HFEF-5 Can	2	4.4453E-001	3.3072E+000	3.3072E-001
Np-237	S	MFC	HFEF-5 Can	2	2.7628E-008	6.8565E-008	6.8565E-009
Pu-239	S	MFC	HFEF-5 Can	2	2.6203E-003	1.5644E-002	1.5644E-003
Sr-90	S	MFC	HFEF-5 Can	2	9.2211E-001	6.7841E+000	6.7841E-001

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Cs-137	HFEF-5 Can	4.4453E-001	3.4000E-001
Sr-90	HFEF-5 Can	9.2211E-001	6.9700E-001

Figure 4. PA Check output screen from RHINO for waste canister SN-139.

Evaluation of PA Checks 9 and 10

PA Checks 9 and 10 were flagged because the cumulative inventory of a radionuclide for the specific generator (MFC), canister type (HFEF-5), and waste form (surface contaminated debris or SC) exceeds the PA 20-year base-case inventory of that radionuclide. The cumulative inventory includes the inventory of all placed canisters plus the proposed canister. PA Check 9 performs the check for all radionuclides in the PA base case inventory (see ECAR-3940, Table 8), and PA Check 10 performs the check for key radionuclides only. Key radionuclides are those that failed a PA pathway screening and were fully evaluated in the PA for the groundwater, air and intruder pathways (see INL 2018, Table 18, column 7). Thus, any canister that is flagged by PA Check 10 will also be flagged by PA Check 9. The cumulative inventory of radionuclides that were screened from the groundwater pathway should be evaluated to determine if the increased inventory (above the PA base case) could have resulted in the radionuclide not being screened out during preparation of the PA (DOE-ID 2018). The cumulative inventory of key radionuclides should be evaluated to determine if the inventory and accompanying dose is within the bounds of the PA. This is checked by examining the increase in performance measures above those calculated and shown in Figure 1 (see Checks 1 through 8) assuming the canisters are placed at the facility.

In general, the exceedances flagged by PA Checks 9 and 10 may be the result of the inventory in previously placed canisters, or it may be due to the inventory of the proposed canister. The details for PA Checks 9 and 10 in Figure 1 shows the inventories of 24 radionuclides (including 7 key radionuclides) already exceed the PA 20-year base-case inventories for surface contamination in HFEF-5 canisters even before the three proposed canisters are considered. Therefore, it is important to understand how much additional inventory of these radionuclides is added to the cumulative facility inventory by the addition of the three proposed canisters, and if the three canisters contain other radionuclides that result in additional exceedances.

Percent Increase in Facility Inventory for Radionuclides Flagged by PA Checks 9 and 10

For evaluation of PA Checks 9 and 10, the inventory of the three proposed canisters was considered together. Table 3 contains a summary of the radionuclide inventories flagged by RHINO for PA Checks 9 and 10. The cumulative inventory of these radionuclides for this generator/canister/waste form already placed at the facility is shown in column 3. Column 4 contains the combined inventory in the three proposed canisters. Column 5 is the sum of columns 3 and 4 and represents the cumulative inventory of surface contamination in all HFEF-5 canisters if the three canisters were placed at the facility. The final column shows the percent increase of each radionuclide for this generator/canister/waste form if the three proposed canisters were placed.

Radionuclides highlighted light blue in Table 3 (Ba-137m, Pa-233, Th-231 and Y-90, see footnote a) were screened out during phase I of a three-phase screening process for the PA groundwater and intruder pathways because their half-lives are less than one year. According to the PA (DOE-ID 2018), the inventory of these radionuclides will have no impact on the PA all-pathway dose and therefore, they require no further evaluation.

Radionuclides shaded green in Table 3 (I-129, Pb-210, Pm-147, Pu-236, Pu-238, Pu-240, Pu-241, Pu-242, Ra-226, Sm-151, Th-230, U-232, U-236 and U-238, see footnote b of Table 3) were not listed in the inventory of any of the three proposed canisters. The cumulative inventory of these radionuclides for this generator/canister/waste form were evaluated in a previous UDQE and because the three proposed canisters do not add additional inventory of these radionuclides, they also require no further evaluation.

The inventory of the six radionuclides shaded pink (Cs-137, Np-237, Sr-90, Th-229, U-233 and U-235) for this generator/canister/waste form exceed the PA base case inventories before the inventory from the three proposed canisters is added. If the inventory from the three proposed canisters is added to the cumulative facility inventory, the percent increase in inventory of Th-229 (0.00001%), U-233 (0.00003%), U-235 (1%) and Np-237 (2%) from addition of the three canisters is very small (Table 3, column 5). It is highly unlikely that increases this small will impact the PA results and the inventory in the three canisters is acceptable. Nevertheless, this will be confirmed by

checking the increase in performance measures which is discussed in the Section, "***Performance Measure Evaluation for PA Checks 9 and 10***."

The inventory increase for the other two pink shaded radionuclides, Sr-90 (46%) and Cs-137 (63%), is more significant. However, these are not key radionuclides for the groundwater pathway, they are key radionuclides associated with the intruder pathway and are evaluated under PA checks 11 and 13 (see Sections "**Evaluation of PA Check 11**" and "**Evaluation of PA Check 13**"). Nevertheless, the inventory of all radionuclides screened from the groundwater pathway was evaluated to determine if the increase would still result in the radionuclides being screened. This is discussed in Section, "***Evaluation of Screened Groundwater Pathway Radionuclides for PA Checks 9 and 10***."

The non-shaded radionuclide in Table 3 (Eu-154) is the only radionuclide flagged by PA check 9 that was not previously flagged by RHINO prior to consideration of the three canisters, and it is only reported in canister SN81. The inventory of Eu-154 in canister SN81 is 437% of the cumulative inventory prior to acceptance of the three canisters. This is not a key radionuclide so the increase was evaluated to determine if the increase would still result in the radionuclides being screened. This is discussed in Section "***Evaluation of Screened Groundwater Pathway Radionuclides for PA Checks 9 and 10***."

Table 3. Summary of radionuclide inventories flagged by RHINO for PA Checks 9 and 10.

1	2	3	4	5	6
Nuclide	Waste Form	Cumulative Inventory of Placed Canisters in HFEF Vault Array (Ci)	Total Inventory of 3 Proposed Canisters (Ci)	Cumulative Inventory of Placed + 3 Proposed Canisters in HFEF Vault Array (Ci)	Percent Inventory Increase if 3 Proposed Canisters were Placed in HFEF Vault Array
Ba-137m[a]	SC	3.6407E+00	2.28E+00	5.919E+00	63%
Cs-137[c]	SC	3.8430E+00	2.41E+00	6.251E+00	63%
Eu-154	SC	1.6682E-03	7.28E-03	8.952E-03	437%
I-129[b]	SC	3.9951E-08	0	3.995E-08	0
Np-237[c]	SC	1.7727E-06	2.77E-08	1.800E-06	2%
Pa-233[a]	SC	1.9376E-06	1.55E-07	2.093E-06	8%
Pb-210[b]	SC	6.8940E-13	0	6.894E-13	0
Pm-147[b]	SC	5.8559E-04	0	5.856E-04	0
Pu-236[b]	SC	9.9496E-07	0	9.950E-07	0
Pu-238[b]	SC	5.5179E-04	0	5.518E-04	0
Pu-240[b]	SC	5.8076E-04	0	5.808E-04	0
Pu-241[b]	SC	4.5874E-04	0	4.587E-04	0
Pu-242[b]	SC	5.8083E-08	0	5.808E-08	0
Ra-226[b]	SC	4.0022E-12	0	4.002E-12	0
Sm-151[b]	SC	3.7328E-03	0	3.733E-03	0
Sr-90[c]	SC	7.4568E+00	3.40E+00	1.086E+01	46%
Th-229[b]	SC	6.5215E-08	7.38E-15	6.522E-08	0.00001%
Th-230[b]	SC	1.0434E-09	0	1.043E-09	0
Th-231[a]	SC	2.4427E-06	3.49E-08	2.478E-06	1%
U-232[b]	SC	1.0918E-05	0	1.092E-05	0
U-233[b]	SC	3.0687E-05	8.90E-12	3.069E-05	0.00003%
U-235[c]	SC	2.4427E-06	3.49E-08	2.478E-06	1%
U-236[b]	SC	2.3698E-06	0	2.370E-06	0
U-238[b]	SC	1.2870E-06	0	1.287E-06	0
Y-90[a]	SC	7.4267E+00	3.40E+00	1.083E+01	46%

a. Blue-shaded radionuclides half-life is less than 1 year. Inventory has no impact on the PA all-pathway dose and requires no evaluation.
b. Green-shaded radionuclides are not listed in the inventory of the three proposed canisters. This radionuclide was flagged due to inventory in prior canister placements which has already been evaluated in a previous UDQE.
c. Pink-shaded radionuclides indicate radionuclides whose inventory prior to placement of the three canisters exceeds the PA base case inventory. The radionuclides are included in each of the three proposed canisters, and this adds to the exceedance of the PA base case inventory.

SC denotes surface contaminated debris waste form.
Radionuclides shown in **BOLD** text are key radionuclides meaning they were not screened and were fully evaluated in the PA in at least one of the three pathways (groundwater, air, or intruder). Other radionuclides (non-key) were screened from all pathways during preparation of the PA (DOE-ID 2018).

Performance Measure Evaluation for PA Checks 9 and 10

Although the percent increase in inventory of radionuclides flagged by RHINO is small with the exception of Cs-137 and Sr-90 (see Table 3) and appears to be acceptable, increases in performance measures were checked to be certain. Figures 2 through 4 show the increase in each performance measure for each of the three proposed canisters. Table 4 contains a summary of the increases in performance measures if all three of the proposed canisters are placed in the facility. The percent increase in each performance measure if the three proposed canisters are added are all less than 1% except for the intruder dose which is 25% (see Table 4, column 7). The increase in intruder dose is due to the higher-than-average inventory of Cs-137 and Sr-90 in the canisters (see

Section "**Evaluation of PA Check 11**"). Nevertheless, the performance measure totals after addition of the three proposed canisters (Table 4, column 8) are a small percent of the limits in RHINO (Table 4, column 3) which for most measures are 1/25th the regulatory limit. This is additional evidence that the canisters are acceptable for disposal.

Table 4. Summary of performance measures for the three proposed canisters.

1	2	3	4	5	6	7	8
Performance Measure (PM)	Period	Limit[a]	Units	PM Before Addition of 3 Proposed Canisters	PM After Addition of 3 Proposed Canisters	Percent Increase in PM from All 3 Proposed Canisters	PM as Percent of Limit After Addition of 3 Proposed Canisters
All Pathways Dose	Compliance	1	mrem/yr	9.4471E-05	9.4471E-05	0.0%	0.0094%
All Pathways Dose	Post Compliance	12.5	mrem/yr	5.5013E-02	5.5013E-02	0.0%	0.44%
Beta-Gamma DE	Compliance	0.16	mrem/yr	6.7099E-05	6.7099E-05	0.0%	0.042%
Beta-Gamma DE	Post Compliance	2.4	mrem/yr	3.9053E-02	3.9053E-02	0.0%	1.63%
Ra-226/228	Compliance	0.2	pCi/L	9.0372E-33	9.0372E-33	0.0%	<1E-25
Ra-226/228	Post Compliance	2.5	pCi/L	8.4423E-07	8.4423E-07	0.0%	0.00003%
Gross Alpha	Compliance	0.6	pCi/L	1.9535E-30	1.9556E-30	0.11%	<1E-25
Gross Alpha	Post Compliance	7.5	pCi/L	3.9323E-06	3.9705E-06	0.97%	0.00005%
Beta-Gamma ED	Compliance	0.16	mrem/yr	3.6711E-05	3.6711E-05	0.0%	0.023%
Beta-Gamma ED	Post Compliance	2	mrem/yr	2.1367E-02	2.1367E-02	0.0%	1.07%
Uranium	Compliance	1.2	ug/L	5.9089E-28	5.9287E-28	0.34%	<1E-25
Uranium	Post Compliance	15	ug/L	1.1256E-05	1.1330E-05	0.66%	0.0001%
Intruder	Compliance	20	mrem/yr	3.0683E-02	3.8258E-02	24.7%	0.191%
Air Pathway	Compliance	0.4	mrem/yr	6.6648E-07	6.6648E-07	0.00%	0.0002%

a. Conservative limit in RHINO set to less than regulatory limit. In most cases the administrative limits are 1/25th the regulatory limits for the compliance period and one-half the regulatory limits for the post-compliance period.

Evaluation of Screened Groundwater Pathway Radionuclides for PA Checks 9 and 10

For key radionuclides screened from the groundwater pathway in the PA (Cs-137 and Sr-90), and for non-key radionuclides flagged by RHINO that are not shaded blue or green in Table 3, it is important to show that the cumulative inventory of each radionuclide in the placed plus three proposed canisters would still be screened from the groundwater pathway as it was during the PA. This was done by calculating the cumulative inventory of each radionuclide after placement of the three canisters as a percent of the maximum allowable inventory allowed by the phase II and III screening steps from the PA. For this calculation the inventory of the placed plus three proposed canisters 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 plus three proposed canisters. The screenings are done on the total facility inventory and are independent of generator, canister type and waste form. It should be noted that Cs-137 and Sr-90 are key radionuclides in the PA, but only for the intruder pathway. Because the three-phase PA screening was performed for the groundwater pathway, Cs-137 and Sr-90 were evaluated with the other non-key radionuclides eliminated during the phase II or III screening steps in the PA.

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 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:

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

here:

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 5 shows that even when the projected cumulative inventory after placement of three proposed canisters (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 key and non-key radionuclides in the three proposed canisters are consistent with the assumptions and screening process/results of the PA, and within the bounds of the PA.

Table 5. 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	Total Inventory of 3 Proposed HFEF-5 Canisters (Ci)[a]	Projected Cumulative Inventory (Placed + 3 Proposed Cans) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of 3 Proposed Cans + Total PA Base Case Inventory (Col3+Col4) (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 3 Proposed Cans as % of Max Allowable Phase II Screening Inventory (Col5/Col7)
Th-229	7.38E-15	6.52E-08[g]	5.35E-08	1.19E-07	1.18E+05	3.39E-06	3.5%
Radionuclides Screened During PA Phase III Screening							
Non-Key Radionuclide	Total Inventory of 3 Proposed HFEF-5 Canisters (Ci)[a]	Projected Cumulative Inventory (Placed + 3 Proposed Cans) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of 3 Proposed Cans + Total PA Base Case Inventory (Col3+Col4) (Ci)	PA Phase III Dose (mrem/yr)[e]	Max Allowable Phase III Screening Inventory (Eqn 2) (Ci/yr)[f]	PA Base Case + Projected Cumulative Inventory after Placement of 3 Proposed Cans as % of Max Allowable Phase III Screening Inventory (Col5/Col7)
Cs-137[h]	2.41E+00	6.25E+00	5.23E+01	5.86E+01	1.00E-40	2.09E+41	<1E-40%
Eu-154	7.28E-03	8.95E-03	3.68E-01	3.77E-01	1.00E-40	1.47E+39	<1E-40%
Sr-90[h]	3.40E+00	1.09E+01	1.97E+01	3.06E+01	1.00E-40	7.88E+40	<1E-40%
U-233	8.90E-12	3.07E-05	8.38E-05	1.14E-04	0.0254	1.32E-03	8.7%

a. Inventory of 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).
f. $Imax_{IIIi}$ from Equation 2 above.
g. Inventory of placed plus 3 proposed canisters exceeds the total PA base case inventory.
h. Cs-137 and Sr-90 are key radionuclides in the PA, but only for the intruder pathway. Because the three-phase PA screening was performed for the groundwater pathway, Cs-137 and Sr-90 were evaluated with the other non-key radionuclides eliminated during the phase II or III screening steps in the PA.

Evaluation of PA Check 11

This check is flagged by RHINO if the inventory of a key radionuclide in a proposed canister exceeds 10% of the PA 20-year base-case inventory for the particular generator, canister type and waste form (see INL 2018, Table 18, column 8). When this occurs, the inventories greater than 10% must be reviewed to determine if: 1) they are anomalous or indicative of a change in waste generation rates, and 2) they are within the bounds of the approved PA.

All three canisters were flagged by RHINO during PA Check 11 for at least one radionuclide in each canister. Table 6 shows the canisters and radionuclides by waste form that were flagged during PA Check 11. Column 7 confirms the canister inventories of each radionuclide are greater than 10% of the PA 20-yr base case inventories for the generator/canister/waste form. Column 9 however shows the canister inventories are a very small percentage of the total RHLLW facility inventory for the particular waste form (surface contamination) for all radionuclides. Thus, based on the low percentages in Table 6, column 9, the inventories of the radionuclides flagged by PA Check 11 are within the bounds of the PA, but they do indicate some radionuclide inventories are

greater than were projected for the PA for this generator and waste form. This is especially true for Cs-137 in all three canisters, and Sr-90 in two of the canisters. These inventories appear to be anomalies compared to other HFEF-5 canisters, but not an indication of a change in generation rates.

Table 6. Summary of radionuclide inventories flagged by RHINO for PA Checks 9 and 10.

1	2	3	4	5	6	7	8	9
Can	Nuclide	Waste Form[a]	Canister Inventory (Ci)	PA 20-yr Base Case Inventory for MFC Legacy and Future Generation Waste in HFEF-5 Canisters for SC Waste Form (Ci)[b]	10% Threshold Inventory (Ci)[c]	Canister Inventory as % of PA 20-yr Base Case Inventory for MFC Legacy and Future Generation Waste in HFEF-5 Canisters for SC Waste Form	PA 20-yr Base Case Inventory for RHLLW Facility and SC Waste Form (Ci)[b]	Can Inventory as % of PA 20-yr Base Case Inventory for RHLLW Facility and SC Waste Form
SN81	Cs-137	SC	1.15E+00	3.31E+00	3.31E-01	35%	9.18E+02	0.13%
SN-107	Cs-137	SC	8.16E-01	3.31E+00	3.31E-01	25%	9.18E+02	0.09%
	Sr-90	SC	2.12E+00	6.78E+00	6.78E-01	31%	6.42E+02	0.33%
SN-139	Cs-137	SC	4.45E-01	3.31E+00	3.31E-01	13%	9.18E+02	0.05%
	Np-237	SC	2.76E-08	6.86E-08	6.86E-09	40%	5.82E-04	0.00%
	Pu-239	SC	2.62E-03	1.56E-02	1.56E-03	17%	3.15E-01	0.83%
	Sr-90	SC	9.22E-01	6.78E+00	6.78E-01	14%	6.42E+02	0.14%

a. SC denotes surface contaminated debris waste form.
b. From ECAR-3940, Table 16. Also see Figures 2, 3 and 4 for numbers in column 5.
c. From INL 2018, Table 18, column 8.

Evaluation of PA Check 13

This check is flagged by RHINO if the proposed canister contains a key radionuclide whose inventory exceeds canister action levels based on the chronic intruder pathway dose standard (see INL 2018, Table 19). The canister action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters. According to the RHLLW WAC (PLN-5446 Section 2.3), action levels were established based on the chronic intruder[4] pathway scenario analyzed in the facility PA. If a radionuclide inventory of a specific canister exceeds an action level, an evaluation must be conducted to ensure the inventory is within the bounds of the PA.

Cs-137 and Sr-90 were the only radionuclide inventories flagged by PA check 13. Cs-137 in all three canisters was flagged and Sr-90 was flagged in two canisters. Table 7 shows the canister inventories range from 131% to 338% of the canister action levels (see Table 7, column 5), but all are less than 2% of the vault array action levels (see Table 7, column 7). Although the levels of Cs-137 and Sr-90 are high, the inventories in the three proposed canisters are not indicative of other canisters. For example, the total inventory of Cs-137 and Sr-90 in all 56 HFEF-5 canisters placed in the HFEF vault array at the time this evaluation was being prepared is 3.84 Ci and 7.46 Ci respectively. For Cs-137, this is 6.3% of the 61.2 Ci action level for the HFEF vault array (see Table 7, column 5), and for Sr-90, this is 6.0% of the 125 Ci action level for the HFEF vault array (see Table 7, column 5). Given the HFEF vault array is filled to approximately 31% of capacity at the time of this evaluation (56 canisters placed out of 180), the amount of Cs-137 and Sr-90 in these canisters remains within the bounds of the PA.

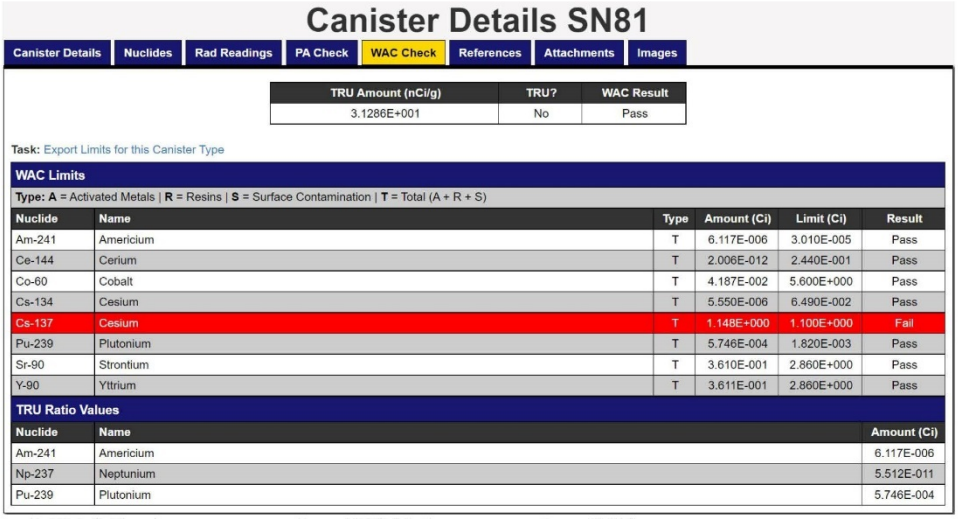
[4] The chronic intruder scenario is the more limiting of the two intruder scenarios (acute and chronic) evaluated in the PA.

Table 7. Details of Sr-90 inventory evaluation for PA check 13.

1	2	3	4	5	6	7
Canister ID	Nuclide	Canister Inventory (Ci)	Canister Action Level for HFEF Vault Array (Ci)	Canister Inventory as % of Canister Action Level for HFEF Vault Array	Vault Array Action Level for HFEF Vault Array (Ci)	Canister Inventory as % of Vault Array Action Level for HFEF Vault Array
SN81	Cs-137	1.15E+00	0.340	338%	61.2	1.9%
SN-107	Cs-137	8.16E-01	0.340	240%	61.2	1.3%
	Sr-90	2.12E+00	0.697	304%	125	1.7%
SN-139	Cs-137	4.45E-01	0.340	131%	61.2	0.7%
	Sr-90	0.92211	0.697	132%	125	0.7%

Evaluation of Flagged WAC Check: Nuclear Safety Limits

Two of the three proposed canisters were flagged by RHINO during the WAC check. Cs-137 in canister SN81 (see Figure 5) and Pu-239 in canister SN-139 (see Figure 6) were flagged as "fail" because they exceed the bounding material-at-risk (MAR) levels evaluated in ECAR-1559 and identified as waste acceptance criteria in the WAC (PLN-5446, Table A-9). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the bounding MAR (threshold levels). If the canister inventory for one or more radionuclides exceeds the threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values evaluated for that waste stream/canister combination. In addition, the cause of each high radionuclide outlier should be investigated to determine if (1) the corresponding waste stream processes have been changed such that the characterization as provided in ECAR-1559 and supporting ECARs is no longer valid and needs updating, or (2) the outlier is attributable to an anomalous condition that is unique to this specific proposed canister.



Canister Details SN81

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

TRU Amount (nCi/g)	TRU?	WAC Result
3.1286E+001	No	Pass

Task: Export Limits for this Canister Type

WAC Limits

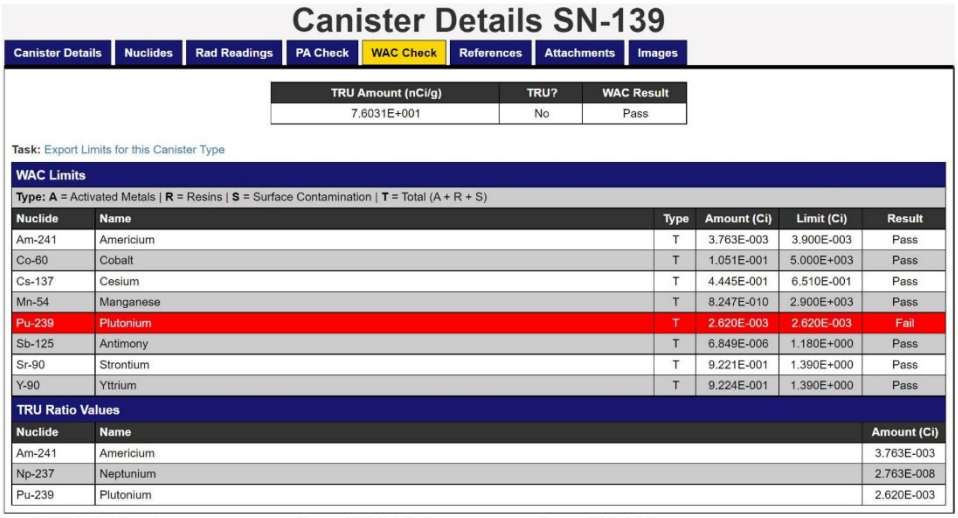
Type: A = Activated Metals | R = Resins | S = Surface Contamination | T = Total (A + R + S)

Nuclide	Name	Type	Amount (Ci)	Limit (Ci)	Result
Am-241	Americium	T	6.117E-006	3.010E-005	Pass
Ce-144	Cerium	T	2.006E-012	2.440E-001	Pass
Co-60	Cobalt	T	4.187E-002	5.600E+000	Pass
Cs-134	Cesium	T	5.550E-006	6.490E-002	Pass
Cs-137	Cesium	T	1.148E+000	1.100E+000	Fail
Pu-239	Plutonium	T	5.746E-004	1.820E-003	Pass
Sr-90	Strontium	T	3.610E-001	2.860E+000	Pass
Y-90	Yttrium	T	3.611E-001	2.860E+000	Pass

TRU Ratio Values

Nuclide	Name	Amount (Ci)
Am-241	Americium	6.117E-006
Np-237	Neptunium	5.512E-011
Pu-239	Plutonium	5.746E-004

Figure 5. WAC Check output screen from RHINO for waste canister SN81.



Canister Details SN-139

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

TRU Amount (nCi/g)	TRU?	WAC Result
7.6031E+001	No	Pass

Task: Export Limits for this Canister Type

WAC Limits

Type: A = Activated Metals | R = Resins | S = Surface Contamination | T = Total (A + R + S)

Nuclide	Name	Type	Amount (Ci)	Limit (Ci)	Result
Am-241	Americium	T	3.763E-003	3.900E-003	Pass
Co-60	Cobalt	T	1.051E-001	5.000E+003	Pass
Cs-137	Cesium	T	4.445E-001	6.510E-001	Pass
Mn-54	Manganese	T	8.247E-010	2.900E+003	Pass
Pu-239	Plutonium	T	2.620E-003	2.620E-003	Fail
Sb-125	Antimony	T	6.849E-006	1.180E+000	Pass
Sr-90	Strontium	T	9.221E-001	1.390E+000	Pass
Y-90	Yttrium	T	9.224E-001	1.390E+000	Pass

TRU Ratio Values

Nuclide	Name	Amount (Ci)
Am-241	Americium	3.763E-003
Np-237	Neptunium	2.763E-008
Pu-239	Plutonium	2.620E-003

Figure 6. WAC Check output screen from RHINO for waste canister SN-139.

ECAR-6333 documents the full dose consequence evaluation for the two canisters. According to ECAR-6333, the potential dose consequence from fire and drop accidents involving canisters SN81 and SN-139 are less than the maximum hypothetical dose evaluated in SAR-419, upon which facility safety controls were evaluated (see Table 8). Because the safety basis bounds the potential accident doses for both canisters, they are deemed acceptable for disposal from a safety basis perspective.

Table 8. Dose consequences from postulated accidents compared to maximum hypothetical dose evaluated in SAR-419.

	Combined Waste		Surface Contaminated Debris	
Canister Fire	**SAR-419 HFEF-5 (rem)[a]**	**SN81 (rem)**	**SAR-419 HFEF-5 (rem)[a]**	**SN-139 (rem)**
Collocated worker dose (100m)	9.7E-05	1.37E-05	1.5E-02	6.41E-05
Public dose (10,900 m)	8.7E-07	1.65E-07	1.1E-04	7.97E-07
Canister Drop	**SAR-419 HFEF-5 (rem)[b]**	**SN81 (rem)**	**SAR-419 HFEF-5 (rem)[b]**	**SN-139 (rem)**
Collocated worker dose (100m)	1.5E+00	2.73E-04	1.5E+00	1.29E-03
Public dose (10,900 m)	1.1E-02	3.30E-06	1.1E-02	1.60E-05

a. SAR-419 Table 3-12
b. SAR-419 Table 3-14

At the time of this evaluation, 56 HFEF-5 canisters have been placed at the RHLLW Disposal Facility and only one other canister has exceeded WAC threshold levels. The other canister, MFC210277, contains new-generation (non-legacy) waste because the waste was generated after 4/21/2015. Therefore, the radionuclide inventories in canisters SN81 and SN-139 that exceed WAC threshold levels are outliers. But because the three proposed canisters contain legacy waste loaded 22 to 27 years ago, there is no reason to suspect a change in waste generation rates that would indicate that this is a trend that is likely to impact future canisters sent for disposal, nor is it a reason to indicate that characterization of canisters needs updating.

Summary

The radionuclide inventories in canisters with unique identifiers SN81, SN-107, and SN-139 that were flagged by RHINO during PA and WAC checks have 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 three proposed canisters are deemed acceptable for disposal.

This evaluation determined that actual inventories of some radionuclides for this generator/canister/waste form are greater than the base case inventory projections used for the PA. Therefore, it is recommended an assessment of the PA base case inventory be performed to help explain the discrepancy.

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.

ECAR-1559, "Evaluation of Facility Inventory and Radiological Consequences to Support RHLLW Disposal Facility Safety Basis," Rev. 6, June 2020.

ECAR-3940, 2018, "Baseline Radionuclide Inventory for the Remote-Handled Low-Level Waste Disposal Facility for Use in the Facility Performance Assessment," Idaho National Laboratory, January 2018.

ECAR-6333, "Dose Consequence Analysis for Canisters SN81, SN128, SN139," Revision 0, Idaho National Laboratory, August 2022.

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-3368, 2021, "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis," Revision 3, Idaho National Laboratory, October 2021.

PLN-5446, 2017, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 1, Idaho National Laboratory, March 2018.

PLN-5501, 2020, "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," Revision 2, Idaho National Laboratory, July 2020.

RH-ADM-5214, 2021, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Idaho National Laboratory, October 2021.

TFR-981, 2018, "Technical and Functional Requirements: Remote Handled-LLW Inventory Online Database," Revision 2, Idaho National Laboratory, June 2018.

Jonathan Jacobson	Jonathan Jacobson	8/25/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
A. R. Prather	A. R Prather	8/25/22
Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	8/25/2022
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
Paul Velasquez	Paul Velasquez	08/25/2022
Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Tim Arsenault	Timothy Arsenault	08/29/2022
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

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

UDQE Tracking No.: UDQE-RHLLW-064

Subject: Canisters SN-128 from RWSF Flagged for PA and WAC Checks during RHINO Acceptance Testing

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 SN-128, a legacy HFEF-5 canister (generated prior to 4/21/2015) containing surface contaminated debris was flagged (did not pass) by RHINO for PA Checks 9, 10, 11 and 13 and for having radionuclide inventories that exceed WAC limits based on nuclear safety considerations. Prior to shipment, details of each waste canister are entered into the Remote-Handled Low-Level Waste (RHLLW) Inventory Online (RHINO) software which performs several checks to evaluate the canister for acceptance. Each RHINO check is explained below.

WAC Check: WAC Nuclear Safety Limits

This flag was checked by RHINO because the canister inventory has three radionuclides (Cs-137, Sr-90 and Y-90) that exceeds nuclear-safety threshold levels derived in ECAR-1559 and presented in the WAC (PLN-5446). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the threshold levels adopted as waste acceptance criteria. If the canister inventory for one or more radionuclides exceeds threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values for that waste stream/canister combination.

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

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

This check was flagged by RHINO because the cumulative inventory of six radionuclides (Ba-137m, Co-60, Cs-137, Eu-154, Sr-90 and Y-90) exceed performance assessment (PA) base-case inventories for this generator, canister type and waste form. The cumulative inventory includes the inventory of all placed canisters, plus the proposed canister. Of the six radionuclides, three (Ba-137m, Eu-154, Y-90) were screened out during preparation of the PA as part of the three-phase screening process, and dose impacts from these radionuclides are not included in the PA all-pathway dose. The other three radionuclides, Co-60, Cs-137 and Sr-90 are "key" radionuclides meaning they were not screened out during preparation of the PA and dose impacts are included in the PA all-pathway dose. According to INL/EXT-18-45184 (2018), the cumulative radionuclide inventory for each generator/canister/waste form must not exceed the PA base case inventories in Table 18. If this occurs, the cumulative inventory is evaluated to determine if the 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 three key radionuclides (Co-60, Cs-137 and Sr-90) exceed the 10% threshold levels of the base-case inventory levels 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 activity 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 13: Canister Action Levels Check

This flag was checked by RHINO because the canister inventories of two key radionuclides (Cs-137 and Sr-90) exceed canister action levels based on the intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels are the array action levels (INL/EXT-18-45184, Table 20) divided by the total number of canisters that may be placed in the array. The canisters action levels represent average canister inventories that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters.

Exceedance of a threshold value or action level that is 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: The canister was flagged by RHINO for one or more exceedances of a threshold value or action level. This does not indicate the canisters are unacceptable for disposal but the canister 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 canisters may be approved for disposal. A UDQE is recommended to address these issues.

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	9/21/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
Timothy Arsenault	Timothy Arsenault	9/21/2022
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: See Explanation below

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

   Yes ☐ No ☒

   Comments: See Explanation below

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

An evaluation was performed for canister SN-128 for checks flagged by RHINO for performance assessment (PA) Checks 9, 10, 11 and 13, and were flagged by RHINO for having radionuclide inventories that exceed waste acceptance criteria (WAC) (PLN-5446) limits based on nuclear safety considerations. Figure 1 shows the canisters details page of RHINO and the results of the PA check.

Canister Details SN-128

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	9.4471E-005	1	mrem/yr	Compliance	9/14/2022
	Yes	All Pathways Dose	5.5013E-002	12.5	mrem/yr	Post Compliance	9/14/2022
2	Yes	Beta-Gamma DE	6.7099E-005	0.16	mrem/yr	Compliance	9/14/2022
	Yes	Beta-Gamma DE	3.9053E-002	2.4	mrem/yr	Post Compliance	9/14/2022
3	Yes	Ra-226/228	9.0372E-033	0.2	pCi/L	Compliance	9/14/2022
	Yes	Ra-226/228	8.4423E-007	2.5	pCi/L	Post Compliance	9/14/2022
4	Yes	Gross Alpha	1.9557E-030	0.6	pCi/L	Compliance	9/14/2022
	Yes	Gross Alpha	3.9704E-006	7.5	pCi/L	Post Compliance	9/14/2022
5	Yes	Beta-Gamma ED	3.6711E-005	0.16	mrem/yr	Compliance	9/14/2022
	Yes	Beta-Gamma ED	2.1367E-002	2	mrem/yr	Post Compliance	9/14/2022
6	Yes	Uranium	5.9287E-028	1.2	ug/L	Compliance	9/14/2022
	Yes	Uranium	1.1330E-005	15	ug/L	Post Compliance	9/14/2022
7	Yes	Intruder	5.1287E-002	20	mrem/yr	Compliance	9/14/2022
8	Yes	Air Pathway	6.6648E-007	0.4	mrem/yr	Compliance	9/14/2022
9	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (All Radionuclides)	-			Compliance	9/14/2022
10	No	PA Base Case Inventory Check by Generator/Canister/Waste Form (Key Radionuclides)	-			Compliance	9/14/2022
11	No	Administrative 10% Canister Inventory Check (Key Radionuclides)	-			Compliance	9/14/2022
12	Yes	Unanalyzed/Not Exempt Nuclides Check	-			Compliance	9/14/2022
13	No	Canister Action Levels Check	-			Compliance	9/14/2022

9. & 10. PA Base Case Inventory Check by Generator/Canister/Waste Form

Note: Nuclides of interest are in bold.

Nuclide	Form	Vault	Generator	Array	East/West	Cumlative PA Amount (Ci)	Limit Inv (Ci)	Canister Contribution (Ci)
Ba-137m [Details]	S	HFEF-5 Can	MFC	2	East	8.3580E+000	1.3503E-002	2.4395E+000
Co-60 [Details]	S	HFEF-5 Can	MFC	2	East	1.5534E+000	7.9139E-001	7.9409E-001
Cs-137 [Details]	S	HFEF-5 Can	MFC	2	East	8.8295E+000	3.3072E+000	2.5786E+000
Eu-154 [Details]	S	HFEF-5 Can	MFC	2	East	1.0323E-002	8.7567E-003	1.2164E-003
I-129 [Details]	S	HFEF-5 Can	MFC	2	East	3.9951E-008	4.4004E-009	
Np-237 [Details]	S	HFEF-5 Can	MFC	2	East	1.8004E-006	6.8585E-008	
Pa-233 [Details]	S	HFEF-5 Can	MFC	2	East	2.0930E-006	2.0675E-017	
Pb-210 [Details]	S	HFEF-5 Can	MFC	2	East	6.8940E-013	4.6793E-017	
Pm-147 [Details]	S	HFEF-5 Can	MFC	2	East	5.8559E-004	1.0861E-004	
Pu-236 [Details]	S	HFEF-5 Can	MFC	2	East	9.9498E-007	1.7684E-007	
Pu-238 [Details]	S	HFEF-5 Can	MFC	2	East	5.5179E-004	1.6411E-004	
Pu-240 [Details]	S	HFEF-5 Can	MFC	2	East	5.8076E-004	6.1053E-005	
Pu-241 [Details]	S	HFEF-5 Can	MFC	2	East	4.5874E-004	3.0447E-004	
Pu-242 [Details]	S	HFEF-5 Can	MFC	2	East	5.8083E-006	1.7068E-008	
Ra-226 [Details]	S	HFEF-5 Can	MFC	2	East	4.0022E-012	4.1935E-016	
Sm-151 [Details]	S	HFEF-5 Can	MFC	2	East	3.7328E-003	4.1756E-004	
Sr-90 [Details]	S	HFEF-5 Can	MFC	2	East	1.8010E+001	6.7841E+000	7.1539E+000
Th-229 [Details]	S	HFEF-5 Can	MFC	2	East	6.5215E-008	1.6844E-015	
Th-230 [Details]	S	HFEF-5 Can	MFC	2	East	1.0434E-009	2.1520E-013	
Th-231 [Details]	S	HFEF-5 Can	MFC	2	East	2.4776E-006	4.7750E-011	
U-232 [Details]	S	HFEF-5 Can	MFC	2	East	1.0918E-005	3.4378E-007	
U-233 [Details]	S	HFEF-5 Can	MFC	2	East	3.0687E-005	3.3797E-006	
U-235 [Details]	S	HFEF-5 Can	MFC	2	East	2.4776E-006	1.8102E-006	
U-236 [Details]	S	HFEF-5 Can	MFC	2	East	2.3698E-006	2.3053E-006	
U-238 [Details]	S	HFEF-5 Can	MFC	2	East	1.2870E-006	9.1146E-007	
Y-90 [Details]	S	HFEF-5 Can	MFC	2	East	1.7982E+001	1.6513E+000	7.1557E+000

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)
Co-60	S	MFC	HFEF-5 Can	2	7.9409E-001	7.9139E-001	7.9139E-002
Cs-137	S	MFC	HFEF-5 Can	2	2.5786E+000	3.3072E+000	3.3072E-001
Sr-90	S	MFC	HFEF-5 Can	2	7.1539E+000	6.7841E+000	6.7841E-001

13. Canister Action Levels (Canister Specific)

Nuclide	Vault	Amount (Ci)	Limit
Cs-137	HFEF-5 Can	2.5786E+000	3.4000E-001
Sr-90	HFEF-5 Can	7.1539E+000	6.9700E-001

Figure 1. Canister Details page of RHINO and the results of the PA checks for canister SN-128.

Exceedance of a threshold value or action level that is flagged by RHINO does not indicate a proposed canister is unacceptable for disposal but the flagged inventory levels must be reviewed in accordance with RH-ADM-5214, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility." 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.

Evaluation of PA Checks 9 and 10

This check was flagged by RHINO because the cumulative inventories of 6 radionuclides (Ba-137m, Co-60, Cs-137, Eu-154, Sr-90 and Y-90) exceed the PA base-case inventories for this generator/canister/waste form (DOE/ID-11421) (see Figure 1, Column 1, Numbers 9 and 10). The cumulative inventories includes the inventories of all placed canisters, plus the proposed canister SN-128. According to INL/EXT-18-45184 (2018), the cumulative radionuclide inventory for each generator/canister/waste form must not exceed the PA base case inventories in Table 18. If this occurs, the cumulative inventory is evaluated to determine if the inventory is within the bounds of the PA.

Of the six radionuclides flagged, two (Ba-137m and Y-90) were screened out during phase I of a three-phase screening process for the PA because their half-lives are less than one year. The inventory of these radionuclides will have no impact on the PA all-pathway dose and they do not require evaluation.

One of the remaining six radionuclides (Eu-154) was screened out during the PA Phase III screening and the remaining three (Co-60, Cs-137 and Sr-90) were not screened out during preparation of the PA and they are considered "key" radionuclides meaning their dose impacts are included in the PA all-pathway dose calculation. Non-key radionuclides that were not screened out during the Phase I screening will be evaluated to determine if the increase in inventory (above the PA base case) could have resulted in the radionuclide not being screened out. For key radionuclides, because the cumulative generator/canister/waste form-specific inventory exceeds the PA base case inventory in Table 18 of INL/EXT-18-45184 (2018), the cumulative inventory will be evaluated to determine if the inventory and accompanying increase in dose is within the bounds of the PA.

Non-key radionuclides screened during PA Phase III screening

The cumulative inventory of the one non-key radionuclide (Eu-154) was examined to determine if the cumulative inventory would have impacted the screening in the PA. This was done by calculating the cumulative inventory of Eu-154 as a percent of the maximum allowable inventory allowed by the Phase III PA screening. The maximum allowable inventory allowed by the Phase III screening was calculated using the following equation:

$$Imax_i(Ci) = 0.4\left(\frac{mrem}{yr}\right) x \frac{I_{PAi}\,(Ci)}{D_{IIIi}(\frac{mrem}{yr})} \quad \text{(Equation 1)}$$

where:

$Imax_i$ = maximum inventory of radionuclide i that would still be screened out during the Phase III PA screening
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 (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 Eu-154 projected cumulative inventory after placement of the proposed canister (column 3) and the total PA base case inventory (column 4) are conservatively summed together, the total (column 5) is an insignificant fraction of the maximum allowable phase III screening inventory (column 7) and would still be screened out. Therefore, the inventory of the non-key radionuclide Eu-154 in the proposed canister is consistent with the assumptions and screening process/results of the PA, and 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 Radionuclide	Canister SN-128 Inventory (Ci)[a]	Projected Cumulative Inventory (Placed + Proposed Canister SN-128) (Ci)[a]	Total PA Base Case Inventory (All Generators, Canisters, Waste Forms) (Ci)[b]	Projected Cumulative Inventory after Placement of Proposed Can + Total PA Base Case Inventory (Col3+Col4) (Ci)	PA Phase III Dose (mrem/yr)[c]	Max Allowable Inventory and Still be Screened in Phase III (Ci)[d]	Projected Cumulative Inventory as % of Max Allowable Phase III Inventory
Eu-154	1.22E-03	1.03E-02	1.56E+01	1.56E+01	1E-40	6.24E+40	2.50E-40%

a. From RHINO acceptance check, see Figure 1.
b. Table 2-14, RHLLW Performance Assessment (DOE/ID-11421).
c. Table 2-29, RHLLW Performance Assessment (DOE/ID-11421). Phase III doses < 1E-40 are shown as 1E-40.
d. $Imax_i$ from Equation 1 above.

Key radionuclides

The remaining three radionuclides (Co-60, Cs-137 and Sr-90) are key radionuclides meaning they were not screened out during preparation of the PA and dose impacts are included in the PA all-pathway dose. Even before disposal of canister SN-128, the cumulative inventories of Co-60, Cs-137 and Sr-90 in the RHLLW disposal facility already exceeds the PA base-case inventory for this generator/canister/waste form (see previously completed UDQE's or subtract Column 2 from Column 3 and compare to Column 4 in Table 3). Thus, the amount in canister SN-128 would add to the exceedance of the cumulative inventory for the PA base-case inventory for this generator/canister/waste form.

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 comparing the projected dose and concentration impacts to the performance objectives (Figure 1, Column 1 numbers 1-7). Table 2 shows the all-pathway dose impact before and after disposal of canister SN-128. The projected all-pathway dose after disposal of canister SN-128 doesn't impact the dose during the compliance period or the post-compliance period. The predicted total dose during both periods is significantly less than the PA limit of 25 mrem/yr from DOE Order 435.1-1. The other doses and concentrations are also much less than performance objectives as shown in Figure 1.

Table 2. All-pathway dose impact after disposal of canister SN-128.

	All Pathway Dose after SN-139 (previous can) (mrem/yr)	All Pathway Dose after SN-128 (proposed can) (mrem/yr)	% Increase in All Pathway Dose after SN-128
Compliance Period	9.4471E-05	9.4471E-05	0.000%
Post-Compliance Period	5.5013E-02	5.5013E-02	0.000%

a. After disposal of SN-139

In addition to comparing the projected doses and concentrations to performance objectives, the projected cumulative inventories for the specific generator/canister/waste form were compared to the total facility PA base-case inventories for the specific waste form (surface contamination) and to the total facility PA base-case inventories for all waste forms. This is done to ensure that the increase in inventory is unlikely to impact the projected waste shipments from other generators. Table 3 shows the projected cumulative inventories as surface contamination are small percentages of the PA base case inventories as surface contamination for each radionuclide of the PA base case (Column 6 = Column 3 ÷ Column 5). However, the projected cumulative inventory of all four key radionuclides are very small percentages of the PA base case inventories of all waste forms (Column 8 = Column 3 ÷ Column 7). Based on these low percentages, the impact on performance objectives is expected to be minimal which is demonstrated by Table 2; and the increased inventory will not impact the amount of waste expected to be shipped by other generators.

Table 3. Summary of key radionuclide inventory evaluation for PA Check 10.

1	2	3	4	5	6	7	8
	Surface Contamination					All Waste Forms	
Radionuclide	Canister SN-128 Inventory (Ci)	Projected Cumulative Inventory (MFC, HFEF-5 Canisters)[a] (Ci)	PA Base-Case Inventory (MFC, HFEF-5 Canisters)[b] (Ci)	PA Base-Case Inventory (All Generators & Canisters) (Ci)	Projected Cumulative Inventory as % of PA Base Case Inventory (All Generators & Canisters)	PA Base-Case Inventory (All Generators, Canisters) (Ci)[b]	Projected Cumulative Inventory as % of PA Base Case Inventory (All Generators & Canisters)
Co-60	7.94E-01	1.55E+00	7.91E-01	7.34E+02	0.212%	3.10E+05	0.001%
Cs-137	2.58E+00	8.83E+00	3.31E+00	9.18E+02	0.962%	9.46E+02	0.934%
Sr-90	7.15E+00	1.80E+01	6.78E+00	6.42E+02	2.805%	6.73E+02	2.677%

a. Includes legacy (before 4/21/15) and future generation (after 4/21/15) waste (see INL/EXT-18-45184).
b. Table 2-14, RHLLW Performance Assessment (DOE/ID-11421).

Evaluation of PA Check 11

This flag was checked by RHINO because the canister inventories of three key radionuclides (Co-60, Cs-137 and Sr-90) 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 activity 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.

Table 4 contains a summary of the flagged radionuclide inventories in canister SN-128 compared to PA base-case inventories for: 1) the specific generator/canister/waste form, and 2) all generators, canister types and waste forms. Column 4 shows that all canister inventories are greater than 10% of the PA base-case inventories for the specific generator/canister/waste form. However, Column 6 shows the canister inventories are a very small percentage of the total RHLLW facility inventory for the particular waste form (surface contamination) for all radionuclides. Column 8 shows the Co-60 inventory is a very small percentage of the total RHLLW facility inventory for all waste forms, but the Cs-137 and Sr-90 percentages went down only slightly. Thus, based on the low percentages in Columns 6 and 8, the inventories of the radionuclides flagged by PA Check 11 are within the bounds of the PA, but they do indicate the radionuclide inventories are greater than were projected for the PA for this generator and waste form, especially for Cs-137 and Sr-90. These inventories appear to be anomalous compared to other HFEF-5 canisters, but not an indication of a change in generation rates.

Table 4. Radionuclide inventory summary for PA Check 11.

1	2	3	4	5	6	7	8
		Surface Contamination				All Waste Forms	
Radionuclide	Canister SN-128 Surface Cont Inventory (Ci)	Total PA Surface Cont Base Case Inventory (MFC, HFEF-5 Canisters) (Ci)[a]	Canister Inventory as % of Total PA Surface Cont Inventory for MFC HFEF-5 Canisters	Total PA Inventory as Surface Cont (All Generators, All Canisters) (Ci)[b]	Canister Inventory as % of Total PA Inventory as Surface Cont for all Generators and Canisters	Total PA Inventory for all Generators, Canisters, and Waste Forms (Ci)[c]	Canister Inventory as % of Total PA Inventory for all Generators, Canisters, and Waste Forms
Co-60	7.94E-01	7.91E-01	1.00%	7.34E+02	0.108%	3.10E+05	0.0003%
Cs-137[d]	2.58E+00	3.31E+00	78.0%	9.18E+02	0.281%	9.45E+02	0.273%
Sr-90[d]	7.15E+00	6.78E+00	105.5%	6.42E+02	1.114%	6.73E+02	1.063%

a. Includes legacy (before 4/21/15) and new-generation (after 4/21/15) waste (see INL/EXT-18-45184).
b. Table 2-14, Column 3, RHLLW Performance Assessment (DOE/ID-11421).
c. Table 2-14, Column 5, RHLLW Performance Assessment (DOE/ID-11421).
d. Cs-137 and Sr-90 are only important for the PA intruder dose calculation. They are not included in the PA all-pathway dose calculation.

Evaluation of PA Check 13

This flag was checked by RHINO because the canister inventories of two key radionuclides (Cs-137 and Sr-90) exceed canister action levels based on the intruder pathway dose standard (see INL/EXT-18-45184, Table 19). The canister action levels are the array action levels (INL/EXT-18-45184, Table 20) divided by the total number of canisters that may be placed in the array. Thus, the canister action levels are indicative of levels that could potentially cause an exceedance of an intruder dose standard if they were representative of all canisters.

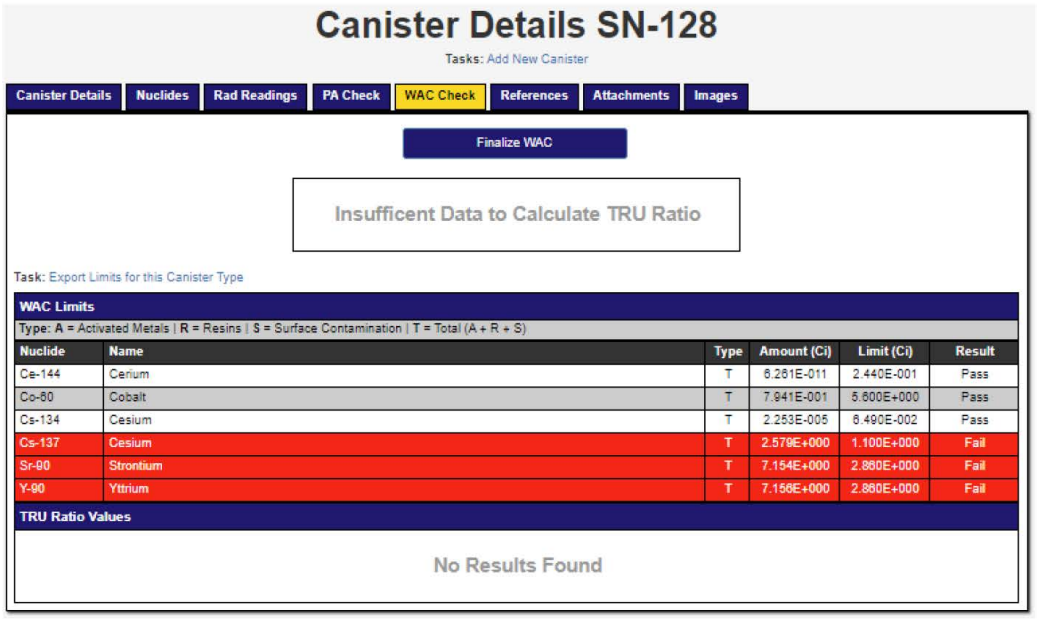
The inventories of Cs-137 and Sr-90 in canister SN-128 exceed the action levels for a canister, but the cumulative inventories (placed + proposed) do not exceed the action levels for the HFEF array. Table 5 shows the Cs-137 and Sr-90 cumulative inventories (Column 4) are both 14.4% (Column 6) of the vault array action levels (Column 5). SN-128 would be the 60th HFEF-5 canister in the HFEF vault array which is 33% of the 180-canister capacity, yet the Cs-137 and Sr-90 cumulative inventories are much smaller percentages of the vault array action levels. This is because most of the HFEF-5 canisters that have been placed contain much less Cs-137 and Sr-90 than the average canister action level. Based on this, the Cs-137 and Sr-90 inventory in canister SN-128 will not impact the conclusions of the PA.

Table 5. Radionuclide inventory evaluation for PA Check 13.

1	2	3	4	5	6
Radionuclide	Canister SN-128 Inventory (Ci)	Cumulative Placed Inventory Prior to SN-128	Cumulative Placed + Proposed Inventory with SN-128	Total Vault Array Action Level	Cumulative Placed + Proposed Inventory with SN-128 as % of Total Vault Array Action Level
Cs-137	2.58	6.25	8.83	61.2	14.4%
Sr-90	7.15	10.9	18.0	125	14.4%

Evaluation of Flagged WAC Check: Nuclear Safety Limits

Canister SN-128 was flagged by RHINO during the WAC check because the Cs-137, Sr-90 and Y-90 inventories exceed the bounding material-at-risk (MAR) levels evaluated in ECAR-1559 and identified as waste acceptance criteria in the WAC (PLN-5446, Table A-9) (see Figure 5). According to ECAR-1559, the radionuclide content of each proposed waste canister must be screened against the bounding MAR (threshold levels). If the canister inventory for one or more radionuclides exceeds the threshold levels, a full dose consequence calculation must be completed to verify the total dose consequence for the proposed waste canister is within the bounding total dose consequence values evaluated for that waste stream/canister combination. In addition, the cause of each high radionuclide outlier should be investigated to determine if (1) the corresponding waste stream processes have been changed such that the characterization as provided in ECAR-1559 and supporting ECARs is no longer valid and needs updating, or (2) the outlier is attributable to an anomalous condition that is unique to this specific proposed canister.



Canister Details SN-128

Tasks: Add New Canister

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

Finalize WAC

Insufficent Data to Calculate TRU Ratio

Task: Export Limits for this Canister Type

WAC Limits

Type: A = Activated Metals | R = Resins | S = Surface Contamination | T = Total (A + R + S)

Nuclide	Name	Type	Amount (Ci)	Limit (Ci)	Result
Ce-144	Cerium	T	6.261E-011	2.440E-001	Pass
Co-60	Cobalt	T	7.941E-001	5.600E+000	Pass
Cs-134	Cesium	T	2.253E-005	6.490E-002	Pass
Cs-137	Cesium	T	2.579E+000	1.100E+000	Fail
Sr-90	Strontium	T	7.154E+000	2.880E+000	Fail
Y-90	Yttrium	T	7.156E+000	2.880E+000	Fail

TRU Ratio Values

No Results Found

Figure 5. WAC Check output screen from RHINO for waste canister SN-128.

ECAR-6333 documents the full dose consequence evaluation for three canisters (SN-81, SN-128 and SN-139). Canister SN-81 and SN-139 were evaluated for acceptance under a separate UDQE (UDQE-RHLLW-062) According to ECAR-6333, the SN-128 potential dose consequence to the collocated worker and the public receptors from canister fire and drop accidents are less than the maximum hypothetical doses evaluated in SAR-419, upon which facility safety controls were evaluated (see Table 6). Because the safety basis bounds the potential accident doses for the canisters, they are deemed acceptable for disposal from a safety basis perspective.

Table 6. Dose consequences from postulated accidents for MFC surface contaminated debris canister SN-128 compared to bounding hypothetical doses evaluated in SAR-419.

Receptor	Potential Dose from Canister Fire (MFC Surface Contaminated Debris) (rem)	Potential Dose from Canister Drop (MFC Surface Contaminated Debris) (rem)	Bounding Hypothetical Dose from SAR-419 Section 3.4.2.2.4 (rem)[a]
Collocated worker (100m)	1.46E-04	2.92E-03	<2.0
Public (10,900 m)	1.21E-06	2.42E-05	<0.02

a. Values bound the maximum dose consequences for all canister types and waste streams.

Summary

The radionuclide inventories in canister SN-128 that were flagged by RHINO during PA and WAC checks have 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 three proposed canisters are deemed acceptable for disposal.

This evaluation determined that actual inventories of some radionuclides for this generator/canister/waste form are greater than the base case inventory projections used for the PA. Therefore, it is again recommended the projected PA base case inventory estimate for this generator/canister/waste form be reevaluated similar to the recommendation made in previous UDQEs.

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.

ECAR-3940, 2018, Baseline Radionuclide Inventory for the Remote-Handled Low-Level Waste Disposal Facility for Use in the Facility Performance Assessment, Idaho National Laboratory, January 2018.

ECAR-6333, 2022, Dose Consequence Analysis for Canisters SN81, SN128 and SN139, Idaho National Laboratory, 2022.

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, 2017, "Waste Acceptance Criteria for the Remote-Handled Low-Level Waste Disposal Facility," Revision 1, Idaho National Laboratory, March 2018.

RH-ADM-5214, 2021, "DOE Order 435.1 Documentation Change Control Process for the RHLLW Disposal Facility," Idaho National Laboratory, October 2021.

SAR-419, 2020, Safety Analysis Report for the Remote-Handled Low-Level Waste Disposal Facility, Revision 2, Idaho National Laboratory.

Jonathan Jacobson	Jonathan Jacobson	9/22/2022
Print/Type Name Originator/FDS	Signature Originator/FDS	Date
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Print/Type Name System Engineer/SE	Signature System Engineer/SE	Date
A. Jeff Sondrup	Jeff Sondrup	9/26/22
Print/Type Name PA/CA SME	Signature PA/CA SME	Date
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Print/Type Name Waste Management/WMP	Signature Waste Management/WMP	Date
Kristen Willis	Kristen Willis	09/26/22
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
Originator/FDS	Originator/FDS	
System Engineer/SE	System Engineer/SE	
PA/CA SME	PA/CA SME	
Waste Management/WMP	Waste Management/WMP	
Nuclear Facility Manger/NFM	Nuclear Facility Manger/NFM	
DOE/ID Representative	DOE/ID Representative	

Appendix B

Compliance and Performance-Monitoring Data for the RHLLW Disposal Facility

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 2022 aquifer and lysimeter sample analysis was performed by GEL Laboratories LLC, Charleston, South Carolina. Data were validated to Radioanalytical Validation Level B by Analytical Quality Associates, Inc., Albuquerque, New Mexico. Aquifer sample and validation results are documented in the following reports:

- Lab Data Report for Sample Data Group: BEA01-3592-01, Work Order 577121.
- Limitations and Validation Report: AR0019_BEA01-3592-01_REV01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2022.
- Lab Data Report for Sample Data Group: BEA01-35966-01_Rev1, Work Order 576944.
- Limitations and Validation Report: AR0018_BEA01-3596-01_REV01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2022.
- Lab Data Report for Sample Data Group: BEA02-3592-01, Work Order 594084.
- Limitations and Validation Report: AR0023_BEA02-3592-01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, November 2022.

Lysimeter sample results are documented in the following reports:

- Lab Data Report for Sample Data Group: BEA01-3611-04, Work Order 581298.
- Limitations and Validation Report: AR0022_BEA01-3611-04 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, July 2022.
- Lab Data Report for Sample Data Group: BEA01-3614-01, Work Order 580593.
- Limitations and Validation Report AR0021_BEA01-3614-01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2022.
- Lab Data Report for Sample Data Group: BEA01-3615-01, Work Order 579027.
- Limitations and Validation Report AR0020_BEA01-3615-01 for Idaho National Laboratory, Analytical Quality Associates, Albuquerque New Mexico, June 2022.

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 2022.
- Table B-2. Average groundwater concentrations in RHLLW Disposal Facility compliance monitoring wells for FY 2022.
- Table B-3. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FY 2019-2022). Data is shown graphically in Figure B-1.

- Table B-4. Summary of RHLLW Disposal Facility lysimeter sampling results for spring 2022.
- Table B-5. Summary of RHLLW Disposal Facility lysimeter sampling results for fall 2021 (FY 2022).
- Table B-6. Summary of sample numbers for RHLLW Disposal Facility lysimeters (FY 2019–2021) and analyte priorities for FY 2022 sampling.
- Figure B-1. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FY 2019–2022).

Table B-1. Aquifer sampling results for RHLLW Disposal Facility compliance monitoring wells for FY 2022.

Constituent	Result Type	Date Collected	Concentration (pCi/L)	Uncertainty	Validation Qualifier
Well USGS-136					
Spring 2022					
Gross alpha	Original	04/18/22	0.591	0.287	UJ
Gross beta	Original	04/18/22	1.92	0.184	
C-14	Original	04/18/22	-0.36	9.24	U
H-3	Original	04/18/22	1110	171	
I-129	Original	04/18/22	-0.0976	0.151	U
Tc-99	Original	04/18/22	5.92	8.6	U
Fall 2022					
Gross alpha	Original	09/16/22	1.62	0.535	
Gross beta	Original	09/16/22	3.45	0.556	
C-14	Original	09/16/22	-15.3	8.85	U
H-3	Original	09/16/22	535	145	
I-129	Original	09/16/22	0.286	0.183	U
Tc-99	Original	09/16/22	-8.51	7.18	U
Well USGS-140					
Spring 2022					
Gross alpha	Original	04/19/22	0.269	0.258	U
Gross beta	Original	04/19/22	3.8	0.277	
C-14	Original	04/19/22	-0.102	9.06	U
H-3	Original	04/19/22	992	161	
I-129	Original	04/19/22	0.0957	0.182	U
Tc-99	Original	04/19/22	16	8.68	U
Fall 2022					
Gross alpha	Original	09/21/22	1.48	0.596	UJ
Gross beta	Original	09/21/22	4.02	0.552	
C-14	Original	09/21/22	3.23	9.36	U
H-3	Original	09/21/22	842	182	
I-129	Original	09/21/22	-0.00982	0.183	U
Tc-99	Original	09/21/22	-8	6.9	U
Well USGS-141					
Spring 2022					
Gross alpha	Original	04/19/22	0.73	0.335	UJ
Gross beta	Original	04/19/22	1.59	0.27	

C-14	Original	04/19/22	2.67	9.22	U
H-3	Original	04/19/22	877	154	
I-129	Original	04/19/22	-0.195	0.181	U
Tc-99	Original	04/19/22	7.91	8.62	U
Gross alpha	Duplicate	04/19/22	1.04	0.295	
Gross beta	Duplicate	04/19/22	2.96	0.264	
C-14	Duplicate	04/19/22	11.1	9.59	U
H-3	Duplicate	04/19/22	773	145	
I-129	Duplicate	04/19/22	0.0158	0.11	U
Tc-99	Duplicate	04/19/22	11.5	8.68	U
Fall 2022					
Gross alpha	Original	09/21/22	-0.112	0.497	U
Gross beta	Original	09/21/22	2.54	0.489	
C-14	Original	09/21/22	-0.921	9.21	U
H-3	Original	09/21/22	874	186	
I-129	Original	09/21/22	0.113	0.131	U
Tc-99	Original	09/21/22	-11.6	6.81	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 2022.

Well	Average Sample Result (pCi/L)[a]					
	Gross alpha	Gross beta	C-14	H-3	I-129	Tc-99
USGS-136	1.62	2.69	U	823	U	U
USGS-140	U/UJ	3.91	U	917	U	U
USGS-141	1.04	2.36	U	841	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. 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 (FY 2019–2022). Data is shown graphically in Figure B-1.

Well	Date	Average Tritium Concentration[a] (pCi/L)
USGS-136	10/1/2018	1380
	4/30/2019	1485
	4/27/2020	932
	4/15/2021	916
	4/18/2022	1110
	9/16/2022	535
USGS-140	10/1/2018	1490
	4/30/2019	1060
	4/28/2020	964
	4/19/2021	739
	4/19/2022	992
	9/21/2022	842
USGS-141	10/1/2018	1140
	4/30/2019	1520
	4/28/2020	815
	4/19/2021	608
	4/19/2022	825
	9/21/2022	874

a. Average values include duplicate sample data if the analyte was detected in both the original and duplicate samples.

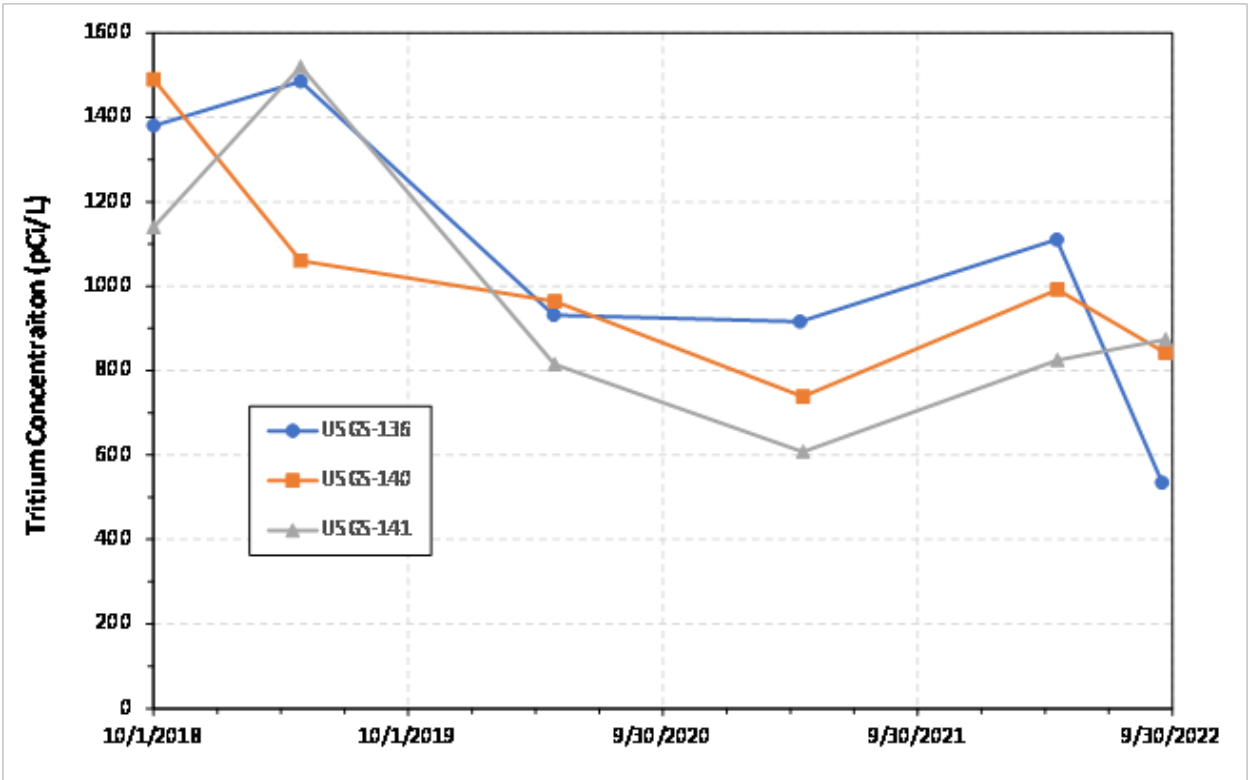

Figure B-1. Average tritium concentration in groundwater in RHLLW Disposal Facility compliance monitoring wells (FY 2019–2022).

Table B-4. Summary of RHLLW Disposal Facility lysimeter sampling results for spring 2022.

Lysimeter	Total Sample Volume (mL)	Sample Result (pCi/L)					
		Gross alpha	Gross beta	C-14	H-3	I-129	Tc-99
Shallow-Alluvium Lysimeters (26–29 ft below land surface)							
PA-North	688[b]	**11.1**	8.02	-11.5 U	626	0.336 UJ	-3.88 U
PA-South	301	5.02	3.91	---	458	---	---
NuPac-West	1109[b]	1.66	2.52	0.213 U (10.2 U)	88.2 U (234 UJ)	-0.789 U	-0.095 J (14.7 U)
NuPac-East	575[a]	1.86 U	4.19	-7.09 U	269 UJ	1.52 U	6.05 U
55-ton-South	473	4.49	1.82	---	-173 U	2.09 U	-10.4 U
HFEF-South	527	3.28	2.74	187 U	27,000	-1.73 U	---
LCC-West	321	4.28	3.55	---	650	---	---
LCC-East	485	1.25 UJ	2.39	---	268 UJ	-1.45 U	-4.14 U
MFTC-West	906[b]	2.03	1.35	3.09 U	372	0.157 U (-0.17 U)	16.1 U
MFTC-East	909[b]	1.5	0.272 U	-1.91 U	85.9 U (262 UJ)	-1.53 U	5.34 U (6.71 U)
Deep-Alluvium Lysimeters (40–44 ft below land surface)							
HFEF-South-45	160	---	---	---	235	---	-6.11 U
LCC-West-45	208	8.68	6.7	---	---	---	---
LCC-East-45	87[c]	**17.9**	15.1	---	---	---	---
Nupac-West-45	35[c]						
Nupac-East-45	43[c]						
55-ton-South-45	18[c]						
MFTC-West-45	36[c]						
MFTC-East-45	20[c]						
Sedimentary-Interbed Lysimeters (170–176 ft below land surface)							
NuPac-SIW	254	3.52	5.61	---	---	---	---
MFTC-West-SIW	349	8.73	6.29	---	106 U	---	---
MFTC-East-SIW	1057[b]	3.75	6.7	-13 U (0.35 U)	-9.22 U	0.83 U (0.11 U)	2.41 U (17.3 U)
Action Level[d] or MCL[e]		10[d]	40[d]	2000[e]	20,000[e]	1[e]	900[e]

a. Sample volume sufficient for full suite of analytes.
b. Sample volume sufficient for full suite of analytes and duplicates (Dup) of some analytes. Duplicate results are shown in parentheses.
c. Sample volumes from six lysimeters combined into single sample volume (239 ml) for analysis.
d. Action levels (PLN-5501) are only defined for gross alpha and gross beta.
e. Federal drinking water maximum contaminant levels (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).

Table B-5. Summary of RHLLW Disposal Facility lysimeter sampling results for fall 2021 (FY 2022).

Lysimeter	Total Sample Volume (mL)[a]	Sample Result (pCi/L)					
		Gross alpha	Gross beta	C-14	H-3	I-129	Tc-99
Shallow-Alluvium Lysimeters (26–29 ft below land surface)							
PA-North							
PA-South							
NuPac-West							
NuPac-East	262	---	---	-5.52 U	744		21 U
55-ton-South							
HFEF-South	172	---	---	---	32,800	-1.64 U	---
LCC-West	122	---	---	---	1070	---	---
LCC-East							
MFTC-West	483	2.62 UJ	0.602 U	5.44 U	359	---	-4.32 U
MFTC-East							
Deep-Alluvium Lysimeters (40–44 ft below land surface)							
HFEF-South-45	64	---	---	---	474	---	---
LCC-West-45	88	---	---	---	751	---	---
LCC-East-45							
Nupac-West-45							
Nupac-East-45							
55-ton-South-45							
MFTC-West-45							
MFTC-East-45							
Sedimentary-Interbed Lysimeters (170–176 ft below land surface)							
NuPac-SIW							
MFTC-West-SIW							
MFTC-East-SIW							
Action Level[b] or MCL[c]		10[b]	40[b]	2000[c]	20,000[c]	1[c]	900[c]

a. Samples collected in the fall are from a limited set of 6 lysimeters and analyzed for tritium. Tritium analysis requires approximately 50 ml. Additional sample volume was analyzed for non-tritium target analytes and were selected based on available volume and data needs for establishing baseline concentrations.
b. Action levels (PLN-5501) are only defined for gross alpha and gross beta.
c. Federal drinking water maximum contaminant levels (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. A blank cell shaded gray indicates no attempt was made to collect a sample.
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 b).

Table B-6. Summary of sample numbers for RHLLW Disposal Facility lysimeters (FY 2019 – FY 2021) and analyte priorities for FY 2022 sampling.

Lysimeter	Depth (ft)	Total Number of Samples Including Duplicates (FY 2019 – FY 2021)					FY 2022 Sample Analyte Priority[a]
		GAB	C-14	I-129	H-3	Tc-99	
Shallow-Alluvium Lysimeters (26–29 ft below land surface)							
PA-North	29	6	4	5	5	3	GAB, H-3 → Then Tc-99, C-14, I-129
PA-South	29	3	1	0	1	0	GAB, H-3 → Then I-129, Tc-99, C-14
NuPac-West	26	4	4	4	3	3	GAB, H-3 → Then Tc-99, C-14, I-129
NuPac-East	26	3	4	3	5	4	GAB, H-3 → Then I-129, C-14, Tc-99
55-ton-South	29	3	4	2	3	2	GAB, H-3 → Then I-129, Tc-99, C-14
HFEF-South	26	4	1	2	4	2	GAB, H-3 → Then C-14, I-129, Tc-99
LCC-West	26	2	2	1	5	2	GAB, H-3 → Then I-129, C-14, Tc-99
LCC-East	26	2	3	2	3	2	GAB, H-3 → Then I-129, Tc-99, C-14
MFTC-West	26	5	4	3	6	4	GAB, H-3 → Then I-129, C-14, Tc-99
MFTC-East	26	4	4	4	4	3	GAB, H-3 → Then Tc-99, C-14, I-129
Deep-Alluvium Lysimeters (40–44 ft below land surface)							
HFEF-South-45	42	1[b]	1[b], 1[c]	1[b]	1[b], 2	1[b]	GAB, H-3 → Then I-129, Tc-99, C-14
LCC-West-45	40	1[b]	1[b], 1[c]	1[b]	1[b], 2	1[b], 1	
LCC-East-45	44	1[b]	1[b], 1[c]	1[b]	1[b], 1	1[b]	
Nupac-West-45	43	1[b]	1[b]	1[b]	1[b], 1[d]	1[b]	
Nupac-East-45	43	1[b]	1[b]	1[b]	1[b], 1[d]	1[b]	
55-ton-South-45	40	1[b]	1[b]	1[b]	1[b], 1[d]	1[b]	
MFTC-West-45	44	1[b]	1[b]	1[b]	1[b], 1[d]	1[b]	
MFTC-East-45	42	1[b]	1[b]	1[b]	1[b], 1[d]	1[b]	
Sedimentary-Interbed Lysimeters (170–176 ft below land surface)							
NuPac-SIW	171	0	0	0	1	0	GAB, H-3 → Then C-14, I-129, Tc-99
MFTC-West-SIW	176	2	0	0	1	0	
MFTC-East-SIW	171	4	3	3	4	3	

a. Analyte priority order from PLN-5501 is gross alpha and gross beta (GAB), C-14, I-129, H-3, Tc-99. For FY 2022, GAB remains the first priority because they are indicator analytes and all samples will be analyzed for GAB after baseline concentrations are established. Tritium (H-3) is next in priority as a result of the unexpectedly high concentration in lysimeter HFEF-South during spring 2020. This is discussed in detail in the FY 2021 annual summary report (INL 2022). Additional priorities are based on number of samples collected from FY 2019 – FY 2021. Gold-shaded cells indicate two or fewer samples for each location and analyte. Analytes with the fewest number of samples are higher priority.
b. Composite sample from eight lysimeters.
c. Composite sample from three lysimeters.
d. Composite sample from five lysimeters.
GAB = gross alpha and gross beta, sometimes referred to as gross alpha/beta.