SECTION A. Project Title: Solvent Extraction Experimental System (Revision 4)

SECTION B. Project Description and Purpose:

Revision 4:

This Idaho National Laboratory (INL) projects involves the installation of a new particle generation production platform at Power Burst Facility (PBF)-622 (Moran), in support of the Wide Area Environmental Sampling (WAES) experimental efforts. The particle generation production platform will be utilized to produce consistent particulate materials of approximately 1 micron or larger size, which will be injected into the existing stack and released to the atmosphere. The particles will be produced from an aqueous feed stock of dissolved metal nitrate salts. These nitrate salts may be a mixture of both radioactive and non-radioactive compounds.

The primary components of the WAES particle production platform to be obtained include a:

- TSI Incorporated Flow Focusing Monodisperse Aerosol Generator (FMAG) 1520,
- Aerodynamic Particle Sizer (APS) 3321,
- Lindberg/Blue M Mini-Mite Tube Furnace; tube furnace equipped with a 1" Inconel 625 tube, and
- Flow meters and desiccant dryers.

System components are to be connected by anti-static carbon impregnated tubing, stainless-steel tubing, and stainless-steel Swagelok valves and connectors to reduce particle loss to the system. The outlet of the system will be connected directly to the existing stack for direct injection of the particles. A containment system will also be obtained to house the particle generation system for contamination control purposes.

Table 1, Rev. 4 below, provides a list of the metals to be utilized for the particle production and the maximum amounts of each anticipated to be released annually. Air Permit Applicability Determination (APAD), INL-17-004 R3, will be revised to incorporate these new materials into the determination.

Table 1, Rev. 4

Compound		Isotope		
Compound	Release Rate, mg/year	Isotope	Release Rate, mg/year	Release Rate, Ci/year
$^{238}UO2(NO3)2$	1.68E+02	^{238}U	1.02E+02	3.45E-08
$^{235}UO2(NO3)2$	1.18E+00	^{235}U	7.11E-01	1.56E-09
$^{236}UO2\ (NO3)2$	6.64E-02	^{236}U	4.00E-02	2.60E-09
$^{90}Sr(NO3)2$	7.56E-02	^{90}Sr	3.18E-02	4.45E-03
$^{134}CsNO3$	6.85E-03	^{134}Cs	4.68E-03	6.08E-03
$^{64}Cu(NO3)2$	7.34E-06	^{64}Cu	2.50E-06	9.75E-03
Cu(NO3)2	1.54E+03			
Ce(NO3)3	1.54E+03			
RuNO(NO3)3	1.54E+03			
Sr(NO3)2	1.54E+03			
CsNO3	1.54E+03			

During the course of this revision, it has been determined that Revision 1 of this ECP has been misinterpreted during previous revisions and should read as follows:

Remove from original ECP (Two bullet points below are removed):

- Solidification (SS) Skid: to mimic the conversion of U/Pu product into a solid oxide form.
- The solidification skid utilizes an evaporator, a precipitation apparatus and a calcining tube furnace to produce a surrogate solid metal oxide. Product solutions from the solvent extraction equipment is first concentrated using the evaporator and then metals are precipitated with oxalic acid. The resulting precipitate is vacuum filtered and transferred to the tube furnace where it is roasted to an oxide form. All off-gas from the solidification skid is contained in the off-gas system.

Additional waste information:

Multiple waste streams will be created during the operation of the equipment. Hazardous mixed waste that could contain nitric acid, sodium hydroxide, various radionuclides and water will result from dissolver, scrubbers and mixer-settler radiological operations. Operation of the non-radioactive mixer-settlers and pulse columns will produce hazardous solutions of nitric acid in water and tributyl phosphate in kerosene. Solid waste consisting mainly of PPE, paper towels and empty plastic/glass sample bottles, etc., will be produced from all the research activities. These will be either low level radioactive(LLW) or non-radioactive streams and will be segregated and managed accordingly. In addition, an industrial reverse osmosis unit will produce a non-contaminated hard water stream.

All streams will be managed through WGS for disposal with mixed, LLW and non-radioactive hazardous materials being shipped offsite to the appropriate treatment facility. Non-contaminated solid waste is disposed of in the trash. The RO water stream will be released to the parking lot (see Releasing hard water e-mail March13, 2025). Below is an estimate of the annual production of each waste stream.

Stream	**Constituents**	**Amount per year**
RO hard water	water	800 liters
Dissolver solution	nitric acid, water, uranium, various radionuclides	1200 liters
NOx scrubber solutions	nitric acid, water, various radionuclides	400 liters
Caustic scrubber solutions	sodium hydroxide, water, various radionuclides	400 liters
LLW solid	PPE, paper towels, empty sample bottles, etc.	250 pounds
Non-rad solutions Aqueous	nitric acid, water	5000 liters
Non-rad solutions Organic	tributyl phosphate and kerosene	200 liters
Non-rad solids	PPE, paper towels, empty sample bottles, etc.	200 pounds

Items that remain active in the ECP (paragraphs below):

This activity includes operation of the solvent extraction equipment (i.e., mixer-settlers and pulse columns) and the solidification skid. The solvent extraction equipment utilizes tributyl phosphate (TBP) in a normal paraffinic hydrocarbon (NPH) as the organic phase and nitric acid (0.01-6M) and 0.25M sodium carbonate as the aqueous phases. Depending programmatic objectives, aqueous feeds could contain non-radioactive surrogates and/or radioactive material including DU, and potentially trace levels of 131-Iodine, 129-Iodine, 125-Iodine, 14-Carbon, 3- Hydrogen, 37Argon, 133-Xenon and 85-Krypton entrained from the dissolution activity described above. At the end of operations, all of the equipment is drained and rinsed with water. The organic phase is separated from the aqueous phase and is typically stored for reuse but it can be solidified on Imbiber beads or other suitable sorbent and disposed of in the facility solid waste. Aqueous solutions with non-radioactive surrogate material may be neutralized and disposed of per WGS. Organic and aqueous solutions containing radioactive materials will be pumped into barrels for eventual disposal as LLW via WGS.

- Cold Chemical (CC) Skid: to deliver required chemicals to the other skids including RO water, acids, bases and organic constituents.
- Head–End (HE) Skid: to mimic the process of dissolution of used nuclear fuel.
- 1st cycle Extraction (1C) Skid: to mimic the separation of U/Pu from the fission products using mixer-settler solvent extraction technologies.
- 2nd cycle Extraction (2C) Skid: to mimic the purification of U/Pu products using mixer-settler solvent extraction technologies.

- Solidification (SS) Skid: to mimic the conversion of U/Pu product into a solid oxide form.

In addition, this EC also covers the installation of a new chiller system to be installed to replace the existing nonfunctioning chillers in the building. This chiller system will increase the cooling current cooling capacity by two times. The new chiller system will utilize 44 pounds of R-410A as the refrigerant and the thermal fluid will consist of a 50/50 mix of water and propylene glycol.

Add to Activity 3: In some instances, additional chemicals either solids, liquids or gases will be introduced directly into the off-gas system.

Revision 3:

This revision includes the temporary use of the following rental equipment for a test at the Idaho National Laboratory (INL) Power Burst Facility (PBF)-622 for a test covered under the existing scope of this ECP:

- Chiller (R407C - 18 lbs)

Mobile generator (provide power for chiller) - 70.1 hp . This generator will fall under the Air Permit Applicability Determination (APAD) -01-83, *Mobile Sources Nonroad Engines - Generic Coverage for diesel engines less than 294 HP.* The existing scope of the project is covered under APAD 17-004.

The temporary rental equipment is necessary to complete the test until the new chiller system (refer to Rev 1 Section below) is permanently installed. The temporary equipment will be located on existing blacktop as noted in Figure 1, Rev 3. The chiller supplies cold water to the existing research process and equipment inside PBF-622 to allow operations to occur. The equipment is estimated to be on-site for one month to be utilized during the one week test event.

Figure 1, Rev 3: Location of chiller

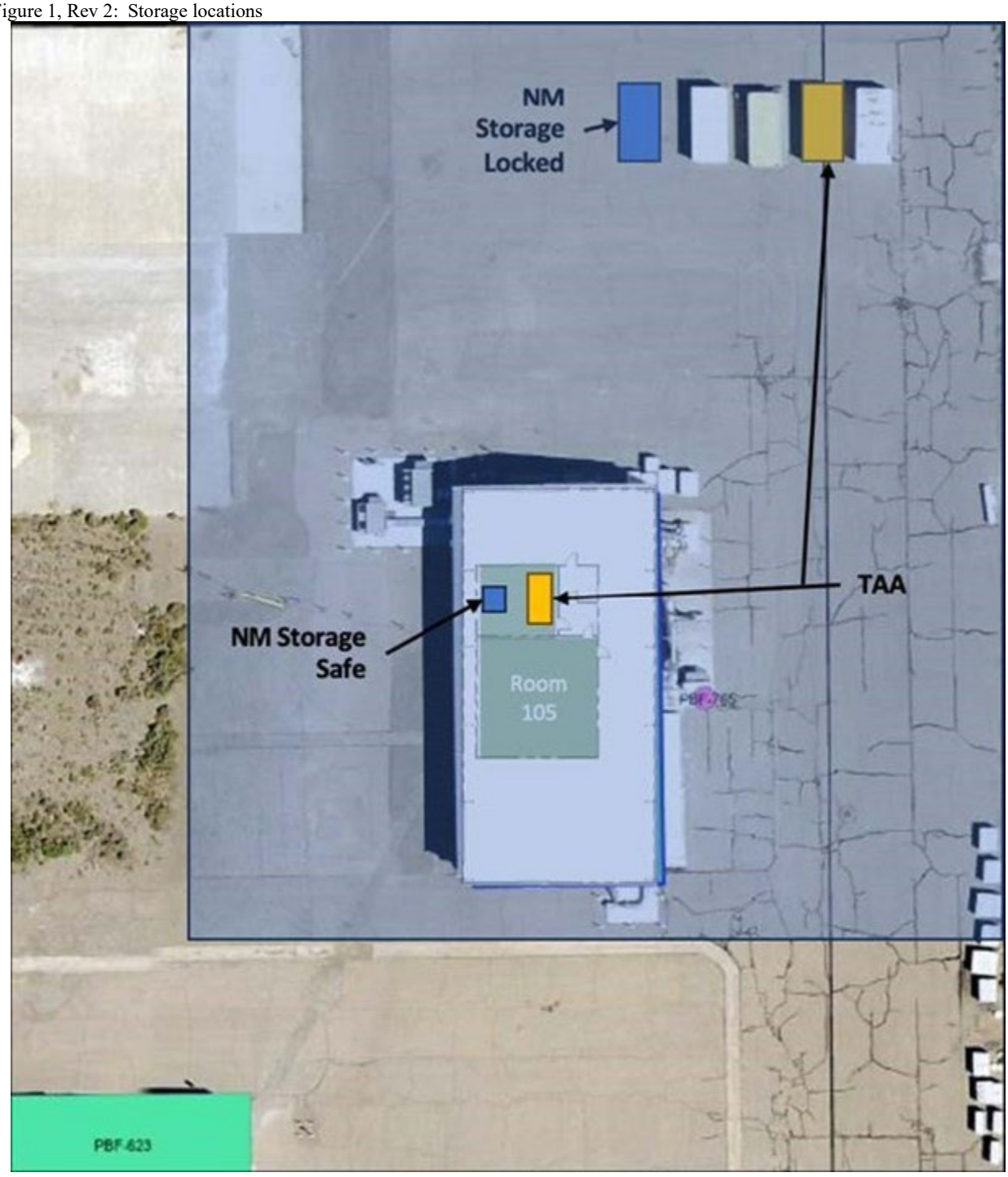
Revision 2:

1. The receipt and storage of 1500 kg of natural uranium (NU) metal in an alloyed cladding at the Moran facility and receipt and storage of a smaller quantity (80 kg) of 1.8% enriched uranium oxide pins and pellets at CPP-651. The majority of the enriched material will only be stored temporarily at CPP-651 before being shipped to its final destination at ORNL and PNNL for R&D projects; 14 kg of the enriched material (250 g U-235 total) will be maintained at INL for eventual use in the Beartooth testbed and Moran testbed under mass-limited criticality controls for fissionable material.

2. The installation of a new head-end chopper skid in Moran to declad this natural uranium and other feedstock sources prior to dissolution using the existing process equipment. INL will install a glovebox/enclosure capable of processing the uranium metal; the inert environment is required due to the potential of generating pyrophoric uranium metal fines during chopping and decanning operations. A decanning extrusion press/cutter and chopper will also be procured to facilitate decladding and sizing for dissolution. The system will also be integrated into the facility off-gas system.

A conex will be purchased to store the material at PBF-622 and placed on existing pavement at the facility.

Figure 1, Rev 2: Storage locations



Revision 1:

- Solidification (SS) Skid: to mimic the conversion of U/Pu product into a solid oxide form.
- The solidification skid utilizes an evaporator, a precipitation apparatus and a calcining tube furnace to produce a surrogate solid metal oxide. Product solutions from the solvent extraction equipment is first concentrated using the evaporator and then metals are precipitated with oxalic acid. The resulting precipitate is vacuum filtered and transferred to the tube furnace where it is roasted to an oxide form. All off-gas from the solidification skid is contained in the off-gas system.

This activity includes operation of the solvent extraction equipment (i.e., mixer-settlers and pulse columns) and the solidification skid. The solvent extraction equipment utilizes tributyl phosphate (TBP) in a normal paraffinic hydrocarbon (NPH) as the organic phase and nitric acid (0.01-6M) and 0.25M sodium carbonate as the aqueous phases. Depending programmatic objectives, aqueous feeds could contain non-radioactive surrogates and/or radioactive material including DU, and potentially trace levels of 131-Iodine, 129-Iodine, 125-Iodine, 14-Carbon, 3- Hydrogen, 37Argon, 133-Xenon and 85-Krypton entrained from the dissolution activity described above. At the end of operations, all of the equipment is drained and rinsed with water. The organic phase is separated from the aqueous phase and is typically stored for reuse but it can be solidified on Imbiber beads or other suitable sorbent and disposed of in the facility solid waste. Aqueous solutions with non-radioactive surrogate material may be neutralized and disposed of per WGS. Organic and aqueous solutions containing radioactive materials will be pumped into barrels for eventual disposal as LLW via WGS.

- Cold Chemical (CC) Skid: to deliver required chemicals to the other skids including RO water, acids, bases and organic constituents.
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- 1st cycle Extraction (1C) Skid: to mimic the separation of U/Pu from the fission products using mixer-settler solvent extraction technologies.
- 2nd cycle Extraction (2C) Skid: to mimic the purification of U/Pu products using mixer-settler solvent extraction technologies.
- Solidification (SS) Skid: to mimic the conversion of U/Pu product into a solid oxide form.

In addition, this EC also covers the installation of a new chiller system to be installed to replace the existing nonfunctioning chillers in the building. This chiller system will increase the cooling current cooling capacity by two times. The new chiller system will utilize 44 pounds of R-410A as the refrigerant and the thermal fluid will consist of a 50/50 mix of water and propylene glycol.Remove from original ECP:

Add to Activity 3: In some instances additional chemicals either solids, liquids or gases will be introduced directly into the off-gas system.

Original:

This EC supersedes EC INL-14-029 and its subsequent revisions (R1-R4). The purpose of this new EC is to combine the previous revisions into an easier to read document that better describes the current operations as a whole. This EC also covers the acquisition of potentially radiologically contaminated mixer-settlers from Lawrence Livermore National Laboratory (LLNL). These mixer-settlers will replace the mixer/settlers discussed in the previous EC. Any proposed changes to operations or processes will be evaluated on a case-by-case basis to ensure the criteria in the Air Permitting Applicability Determination (APAD), 17-004 are not exceeded. If required, a new revision of this EC and APAD will be created.

A pilot plant located inside PBF-622 is designed to mimic several aspects of used nuclear fuel reprocessing in the Plutonium, Uranium, Reduction, EXtraction (PUREX) process for the extraction and recovery of uranium (U) and plutonium (Pu) from dissolved used nuclear fuel. The program objectives are to utilize the pilot plant as a training and research tool for classified and unclassified programs. Non-radioactive surrogates and some radioactive materials may be used in the operations. The existing pilot plant consists of eight skids that are a series of modular platforms on which the processes operate. The skids and their corresponding equipment components and operational processes are:

- Pulse Column Extraction (PC) Skid: to mimic the separation of U/Pu from the fission products using pulse column solvent extraction technologies.
- NOx Scrubber Skid: to mimic the treatment of NOx off-gas generated during the dissolution of used nuclear fuels.
- Abatement Skid: to mimic the additional off-gas treatment technologies that could be utilized in a PUREX process.

The specific operation of the pilot plant will be tuned to achieve the desired outcome depending on the programmatic testing objectives. Most operations will be completed in a single day, while extended tests may require up to 10 (24-hour) days to complete. The anticipated activities that could be performed with the pilot plant either individually or together are listed and subsequently described below:

1. Equipment assembly, modification and installation
2. Dissolution
3. Operation of the off-gas systems
4. Operation of the separations systems

5. Sampling of the processes

6. Clean-up

Activity 1

The assembly and/or disassembly, modification and/or installation of equipment and its maintenance is required continually to meet program objectives. In some instances, this could include the reconfiguration or complete replacement of existing components or in extreme cases entire skids.

Activity 2

Dissolution is designed to mimic the conversion of solid nuclear materials into a liquid form amenable to subsequent liquid-liquid solvent extraction separation methods. The activities are performed on the head-end skid inside the dissolver vessel and off-gas from the resulting reactions are contained in the off-gas system. The dissolver vessel's flexible design and operation provides the capability to dissolve metal and/or oxide non-radioactive surrogates (e.g., iron (Fe)) and/or un-irradiated depleted uranium (DU). The dissolver is designed to be a batch process to convert a nominal 20 kg batch of solid DU (in the form of solid cylindrical UO2 oxide pellets) into ~65 liters of 300 g/L uranium solution for feed to the solvent extraction separation process. Nitric acid (up to 13M HNO3) heated to ~95°C is used to dissolve the solids. In some instances, additional chemicals may be added to the solution in order to simulate the desired solution and resulting off-gas compositions. These chemicals could be either gaseous or liquid and could include O2, NO, NO2, tracer levels of 131-Iodine, 129-Iodine, 125-Iodine, 14-Carbon, 3-Hydrogen, 37-Argon, 133- Xenon and 85-Krypton. This activity requires the storage and handling of the DU pellets and other chemicals used in the process. Limits of these chemicals are described in the Air Permitting Applicability Determination (APAD), 17-004.

Activity 3

An off-gas system is included with the pilot plant to accommodate and contain gases and aerosols evolved during operation. The off-gas system is maintained under slight negative pressure during operation. The off-gas system removes the gases from the dissolver, all the vessels and the building. Gases evolved from the dissolver pass through two off-gas condensers and the condensate is recycled back to the dissolver. Gases leaving these condensers are routed to a NOx scrubber to further remove NO, NO2, and residual acid gases. The exiting gas may be routed to the abatement skid for testing two off-gas abatement treatment systems consisting of a caustic scrubber (up to 2M NaOH) and a silver zeolite bed. If desired, both the NOx scrubber and abatement skid may be bypassed. All of the resulting off- gas then passes through a blower and out the off-gas stack.

Activity 4

The solidification skid utilizes an evaporator, a precipitation apparatus and a calcining tube furnace to produce a surrogate solid metal oxide. Product solutions from the solvent extraction equipment is first concentrated using the evaporator and then metals are precipitated with oxalic acid. The resulting precipitate is vacuum filtered and transferred to the tube furnace where it is roasted to an oxide form. All off-gas from the solidification skid is contained in the off-gas system.

Activity 5

During operation, sampling of liquid samples from the solvent extraction systems as well as from the off-gas systems occurs periodically. The samples can be collected via disposable pipettes or though sampling ports on the systems. Gaseous samples are collected through sampling ports via automatic samplers (e.g., NOx analyzers, stack analyzers, etc.) or by evacuated gas bombs. Once analysis is complete, remaining samples will be disposed of per WGS.

Activity 6

At the end of operations, all of the equipment is drained and rinsed with water. The organic phase is separated from the aqueous phase and is typically stored for reuse but it can be solidified on Imbiber beads or other suitable sorbent and disposed of in the facility solid waste. Aqueous solutions with non-radioactive surrogate material may be neutralized and disposed of per WGS. Organic and aqueous solutions containing radioactive materials will be pumped into barrels for eventual disposal as LLW via WGS.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Rev 4: APAD INL-17-004 must be updated prior to the start of the project.
Rev 0-3: Emissions of NOx and radionuclides during operation are addressed in APAD 17-004, as described/required in this ECP.

Discharging to Surface-, Storm-, or Ground Water

Rev 0-4: Water used to operationally check the new equipment will be re-used to the extent practicable. Wastewater will be discharged to the CFA sewage treatment plant.

Disturbing Cultural or Biological Resources

INL-19-012 Cultural: This ECP does not appear to have been reviewed by CRMO. However, the actions proposed were within PBF-622, which is not eligible,
INL-19-012 R1: Cultural: Pursuant to the 2023 Programmatic Agreement, this federal undertaking is excluded from Section 106 review and the proposed activity results in no historic properties affected.
INL-19-012 R2: Cultural: Pursuant to the 2023 Programmatic Agreement, this federal undertaking is excluded from Section 106 review and the proposed activity results in no historic properties affected.
INL-19-012 R3: Cultural: Pursuant to the 2023 Programmatic Agreement, this federal undertaking is excluded from Section 106 review and the proposed activity results in no historic properties affected.
INL-19-012 R4: Cultural: Pursuant to the 2023 Programmatic Agreement, this federal undertaking is excluded from Section 106 review and the proposed activity results in no historic properties affected.

Generating and Managing Waste

Rev 4: Multiple waste streams will be created during the operation of the equipment. Hazardous mixed waste that could contain nitric acid, sodium hydroxide, various radionuclides and water will result from dissolver, scrubbers and mixer-settler radiological operations. Operation of the non-radioactive mixer-settlers and pulse columns will produce hazardous solutions of nitric acid in water and tributyl phosphate in kerosene. Solid waste consisting mainly of PPE, paper towels and empty plastic/glass sample bottles, etc., will be produced from all the research activities. These will be either low level radioactive(LLW) or non-radioactive streams and will be segregated and managed accordingly. In addition, an industrial reverse osmosis unit will produce a non-contaminated hard water stream.

All streams will be managed through WGS for disposal with mixed, LLW and non-radioactive hazardous materials being shipped offsite to the appropriate treatment facility. Non-contaminated solid waste is disposed of in the trash. The RO water stream will be released to the parking lot (see Releasing hard water e-mail March13, 2025)
Rev 0-3: Non-radioactive industrial waste streams are expected to include filtrate from a reverse osmosis water purification system, PPE, and common washwater. Non-radioactive liquid waste will be taken to the CFA sewage treatment plant for disposal. All water disposed at the STP will comply with STP acceptance criteria. Hazardous and mixed waste are expected to include acids, acid mixed with DU and/or NU. Corrosive-only hazardous waste may be subjected to elementary neutralization and disposed at the CFA STP. Mixed waste will be managed as hazardous waste. Waste from lab analyses will be characterized and managed appropriately. Radioactive-only waste will be managed in accordance with appropriate requirements. All Solid Waste will be managed by WGS.

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

NA

SECTION D. Determine Recommended Level of Environmental Review, Identify Reference(s), and State Justification: Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not “connected” to other action actions (40 CFR 1508.25(a)(1) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References: B1.2 "Training exercises and simulations", B1.30 "Transfer actions", B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

Justification: Based on the purpose and need and description of the proposed action and potential environmental impacts, the proposed action fits within the class of actions that is listed in Appendix B CX B1.2, B1.30 and B3.6. There are no extraordinary circumstances related to the proposed action that may affect the significance of the environmental effects of the proposal (10 CFR 1021.410(b)(2)). The proposed action has not been segmented to meet the definition of a categorical exclusion (10 CFR 1021.410(b)(3)). This proposal is not connected to other actions with potentially significant impacts, is not related to other actions with individually insignificant but cumulatively significant impacts, and is not precluded by 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement (10 CFR 1021.410(b)(3)).

Authorizing the proposed action will not (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including DOE and/or Executive orders; (2) require siting of new facilities or expansion of existing facilities; (3) disturb hazardous substances, pollutants, or contaminants; (4) adversely affect environmentally sensitive resources; or (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species.

B1.2 Training exercises and simulations. Training exercises and simulations (including, but not limited to, firing-range training, small-scale and short-duration force-on-force exercises, emergency response training, fire fighter and rescue training, and decontamination and spill cleanup training) conducted under appropriately controlled conditions and in accordance with applicable requirements.

B1.30 Transfer actions. Transfer actions, in which the predominant activity is transportation, provided that (1) the receipt and storage capacity and management capability for the amount and type of materials, equipment, or waste to be moved already exists at the receiving site and (2) all necessary facilities and operations at the receiving site are already permitted, licensed, or approved, as appropriate. Such transfers are not regularly scheduled as part of ongoing routine operations.

B3.6 Small-scale research and development, laboratory operations, and pilot projects. Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.

Approved by Robert Douglas Herzog, DOE-ID NEPA Compliance Officer on: 5/27/2025