DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-20-024

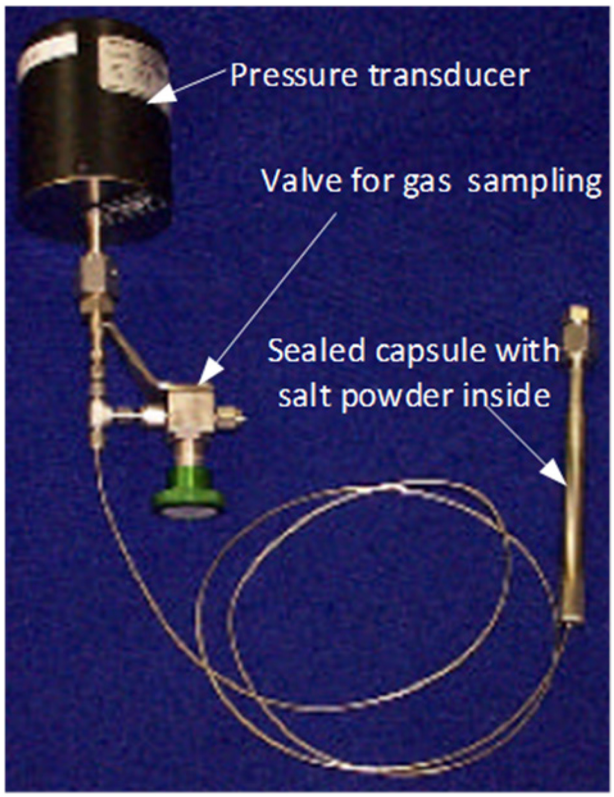
SECTION A. Project Title: Investigation into the Radiolysis Effects in Surrogate Nuclear Fuel Salts

SECTION B. Project Description and Purpose:

Idaho National Laboratory (INL) needs to understand the radiolytic behavior of solid and molten chloride salt in prototypical nuclear reactor spent fuel radiation environments to support and validate liquid molten salt fueled nuclear reactor designs and operations.

The proposed action irradiates target salts (i.e., NaCl-PuCl3 binary with and without added impurities) at various temperatures using sealed capsules. The project will instrument capsules to measure and characterize generated gases. The project proposes to complete these irradiations at both using the Idaho Accelerator Center at Idaho State University (ISU) and the ATR gamma tube (located within the canal at ATR). Irradiations will be performed at 30°, 175°, 350°, 550°, and 750°C. At 30° and 175°C, the project will seal the stainless-steel capsules using Swagelok structures, which have been tested by researchers at Oak Ridge National Laboratory (see Figure 1). At high temperatures 350°, 550°, and 750°C, the project will make the stainless-steel capsules welding them in an inert argon gas atmosphere glovebox. The proposed action will not generate waste from the welding process.

Figure 1. Swagelock structure tested by ORNL.



This environmental checklist outlines the tentative scope of work and gives additional technical information in the following discussion:

<u>Task 1 – Conceptual Design and Experiment Planning</u>
During Task 1, the project will gather the functional and operational requirements (F&OR) of the experiment. INL proposes to develop a draft Experiment Plan which will include the following:

- Test Matrix
- Target Salt Composition Details
- Expected Host Facility with Identified Alternatives
- Detailed Cost Estimate
- Detailed Schedule
- Discussion of Risks
- Data Quality.

Following the F&OR, the project will develop a conceptual experiment design.

<u>Task 2 – Final Design and Fabrication</u>
For Task 2, the project will finalize experiment design and fabrication. INL will reuse experimental equipment, when feasible, to reduce experiment cost and schedule. The proposed action will use final approved drawings to fabricate and procure components for the experiment hardware assembly. Based on the

final design and fabrication details, the project will update the Experiment Plan. The proposed action requires purchasing some instruments (such as high-resolution pressure transducers, data acquisitions, etc) and heaters, and fabricating furnaces.

This Task also synthesizes the target salt for use in the experiment. These salts, where applicable, will be characterized prior to loading in the experiment capsules. The characterization activities will consist of mass, elemental composition, melting point, and density at a minimum.

<u>Task 3 – Experiment Execution</u>
In Task 3, INL installs the experiment hardware and performs radiolysis experiments. The project may also perform experiments using the Idaho Accelerator Center at ISU in Pocatello, Idaho. The project measures pressure changes in the capsule in real-time to understand the salt's radiolytic behavior. The experiments irradiate salts at various temperatures throughout the liquid and solid phases. The project also measures and characterizes gases generated during irradiation.

<u>Task 4 – Final Report and Closeout</u>
After experiment execution, the project will tabulate and summarize the results in a formal report.

ADDITIONAL TECHNICAL INFORMATION
The project anticipates that chloride solid salts radiolysis will result in NaCl and UCl3 salt decomposition which 1) forms Na, U, and chlorine gas, 2) possible valence changes of U3+ to higher valence U5+, and 3) produces other radiolysis products depending on the salt composition and impurity concentration. In general, sealed capsules containing chloride salt powders can be used to understand radiolysis, and a pressure gauge and a gas sampling valve can be connected to the sealed capsule for real-time monitoring of the pressure changes and for gas analysis following the gamma irradiation experiments. To improve pressure gauge sensitivity, the experiment minimizes the volume above the salt using a small diameter tube for the pressure gauge. This sealed capsule with pressure monitoring can be used in the proposed gamma irradiation facilities, including Co-60, X-ray irradiation facility at ISU, and spent fuel pool at the Massachusetts Institute of Technology Reactor (MITR). Project personnel will measure the gas and salt composition after experiment completion, not in real-time.

The proposed action measures gas composition in the sealed capsule using the gas sampling valve and feeding the gas sample to a gas chromatography mass spectrometry (GC-MS) for analysis. Researchers analyze salt composition using multiple standard analytical technologies such as X-ray diffraction, inductively coupled plasma-mass spectroscopy (ICP-MS), etc.

Reactor developers desire the ability to monitor the gamma irradiation process online. To support online monitoring, a gas chromatography/mass spectroscopy (GCMS) instrument can be connected to the gas sampling valve during gamma irradiation. But because the GCMS samples the gas using a vacuum pump, the project cannot measure pressure change within the sealed capsule in real time.

Currently, reports on gamma irradiation of liquid chloride salts are lacking. In theory, methodologies for solid salts can be used for liquid salts by using a sealed capsule with pressure gauge and gas sampling valve, but issues arise with gamma irradiation of liquid salts. Experiments require a heater to melt the chloride salt, because gamma irradiation may not produce enough heat and does not allow precise temperature control.

Liquid salt also has the potential for the salt vapor to condense and deposit at the cold section and block the pressure monitoring tube, so the project does not recommend real-time monitoring of the gas above the liquid salt by GC-MS. The sealed capsule offers a better option for liquid salt irradiation.

The proposed action will not modify buildings.

WASTE MANAGEMENT
Nearly all plutonium at MFC was supplied by defense programs. MFC involvement with defense-related programs and materials has been continuous since the earliest days of operation. MFC facilities that are qualified for plutonium handling, including FMF and HFEF, are contaminated with transuranics from these programs.

Waste associated with project activities is eligible for disposal at the Waste Isolation Pilot Plant (WIPP). National Environmental Policy Act (NEPA) coverage for the transportation and disposal of waste to WIPP are found in the Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997), respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling transuranic (TRU) waste at the generator-storage facilities would be conducted. The Department has analyzed TRU waste management activities in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE/EIS-200-F, May 1997). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

There is the potential to generate low level waste (LLW). The environmental impacts of transferring LLW from the INL Site to the Nevada National Security Site were analyzed in the 2014 Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426) and DOE's Waste Management Programmatic EIS (DOE/EIS-200). The fourth Record of Decision (ROD) (65 FR 10061, February 25, 2000) for DOE's Waste Management Programmatic EIS established the Nevada National Security Site as one of two regional LLW and MLLW disposal sites.

Onsite disposal of RH-LLW was analyzed in the Final Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site (DOE/EA-1793, 2011).

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

During the irradiation experiments which use sealed capsules, there will be no air emissions. But after the experiments, the gas in the sealed capsules will be analyzed by Gas chromatography–mass spectrometry (GC-MS), a standard process for analyzing gas compositions. An Air Permitting Applicability Determination (APAD) may be required.

Generating and Managing Waste

Irradiated sample debris and PIE waste are expected to generate research and development-related TRU waste and mixed TRU waste. TRU waste generated for the experiments will be less than about 1 cm^3 over a 4-month period. Categorizing this material as waste is supported under DOE O 435.1, Att. 1, Item 44, which states "…Test specimens of fissionable material irradiated for research and development purposes only…may be classified as waste and managed in accordance with this Order...".

The proposed action has the potential to generate small amounts of hazardous waste from cleaning solvents, solders, metals; scrap metal (held for recycle whenever appropriate). Waste Generator Services (WGS) will evaluate, characterize, and manage hazardous waste. In addition, WGS may establish satellite accumulation areas to manage hazardous waste.

Small amounts of low-level waste would be generated in the form of personal protective equipment (PPE) and towels used for cleaning and polishing.

Project activities would also result in the generation of small amounts of industrial waste.

Project personnel would work with WGS to properly package and transport regulated, hazardous or radioactive material or waste according to laboratory procedures.

Releasing Contaminants

Chemicals will be used and will be submitted to chemical inventory lists with associated Safety Data Sheets (SDSs) for approval prior to use. The Facility Chemical Coordinator will enter these chemicals into the INL Chemical Management Database. All chemicals will be managed in accordance with laboratory procedures. When dispositioning surplus chemicals, project personnel must contact the facility Chemical Coordinator for disposition instructions.

Although not anticipated, there is a potential for spills when using chemicals or fueling equipment. In the event of a spill, notify facility environmental staff. If environmental staff cannot be contacted, report the release to the Spill Notification Team (208-241-6400). Clean up the spill and turn over spill cleanup materials to WGS.

Using, Reusing, and Conserving Natural Resources

All applicable waste will be diverted from disposal in the landfill when possible. Project personnel will use every opportunity to recycle, reuse, and recover materials and divert waste from the landfill when possible. The project will practice sustainable acquisition, as appropriate and practicable, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting. have recycled content and are non-toxic or less-toxic alternatives. New equipment will meet either the Energy Star or SNAP requirements as appropriate (see http://www.sftool.gov/GreenProcurement/ProductCategory/14).

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: 10 CFR 1021, Appendix B to subpart D, items B3.6, "Small-scale research and development, laboratory operations, and pilot projects"

Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (1996)

Final Environmental Impact Statement for the Waste Isolation Pilot Plant (DOE/EIS-0026, October 1980) and Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant (SEIS-I) (DOE/EIS-0026-FS, January 1990)

Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, September 1997)

Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426, December 2014).

Justification: The proposed R&D activities are consistent with CX B3.6 "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); 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 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."

After PIE, irradiated capsule pieces/contents and PIE remnants will be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in the HFEF or the Radioactive Scrap and Waste Facility (RSWF) in accordance with DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996). Ultimate disposal of the irradiated test pin segments and PIE remnants will be along with similar DOE-owned irradiated materials and experiments currently at MFC. Irradiated sample debris and secondary waste could total as much as 20-30 Kg. Categorizing this material as waste is supported under Department of Energy Order (DOE O) 435.1, Att. 1, Item 44, which states "…Test specimens of fissionable material irradiated for research and development purposes only…may be classified as waste and managed in accordance with this Order...".

NEPA coverage for the transportation and disposal of waste to WIPP are found in the Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997), respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling TRU waste at the generator-storage facilities would be conducted. The Department has analyzed TRU waste management activities in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE /EIS-200-F, May 1997). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

The environmental impacts of transferring LLW from the INL Site to the Nevada National Security Site were analyzed in the 2014 Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426) and DOE's Waste Management Programmatic EIS (DOE/EIS-200). The fourth Record of Decision (ROD) (65 FR 10061, February 25, 2000) for DOE's Waste Management Programmatic EIS established the Nevada National Security Site as one of two regional LLW and MLLW disposal sites.

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on: 04/22/2020