DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-18-018 R1

SECTION A. Project Title: Aluminum Clad Spent Nuclear Fuel Long Term Dry Storage Technical Issues

SECTION B. Project Description and Purpose:

Revision 1:

This revision identifies the use of the gamma irradiator located in the Energy Innovation Laboratory (EIL) to perform the radiolysis activities in Task 2. The use of the gamma irradiator located in the Fuels and Applied Science Building (FASB) would be as a backup in case the irradiator in EIL is unavailable. EIL irradiator is being used due to significantly higher doses to reduce our irradiation clock-time and to improve efficiencies since the coupons and analysis equipment are already in EIL. No unsealed radioactive material is allowed in EIL. All other tasks will be performed at the Materials and Fuels Complex.

All previous conditions and project-specific instructions from the original EC remain valid.

Original EC:

A more complete understanding of how aluminum clad spent nuclear fuel (ASNF) behaves during extended dry storage is needed to support a technical basis for the continued storage of this material. This improved understanding of ASNF behavior is critical to safe, extended dry storage in current and future configurations and to provide information for future transportation, conditioning, and disposal of ASNF. The Department of Energy (DOE) Spent Nuclear Fuel Working Group's (SNFWG) report, "Aluminum-Clad Spent Nuclear Fuel: Technical Consideration and Challenges for Extended (>50 Years) Dry Storage" (DOE/ID RPT-1575, June 2017) identified five knowledge gaps and technical data needs. This report also made several recommendations including one to develop an action plan to identify technical and engineering activities and analyses to address the identified knowledge gaps and technical data needs.

The five data and knowledge gaps that need to be addressed to help inform decision-makers on the environmental, safety, and long-term programmatic risks associated with a management strategy for ASNF in extended (i.e., greater than 50 years) dry storage have been identified as follows:

1. Behavior and chemistry of oxyhydroxide layers that form on ASNF for the range of ASNF fuel designs and dry storage configurations
2. Resolution of radiolytic gas generation data for ASNF oxyhydroxide layers (radiolysis is the molecular decomposition of a substance by ionizing radiation, and this decomposition can generate combustible and corrosive gases)
3. Combined effect of episodic breathing and radiolytic generation of corrosive gases in sealed and vented systems
4. Performance of research test reactor ASNF in dry storage systems
5. Effects of high-temperature (i.e., greater than 100°C) drying on the chemistry and behavior of oxyhydroxide layers.

The proposed action fills these gaps by completing the following six tasks, which are further detailed in "Aluminum Clad Spent Nuclear Fuel Long Term Dry Storage Technical Issues Action Plan – Technical and Engineering Activities" (INL/EXT-17-93408, November 2017 and February 2018 Technical Task Plan):

1. Oxyhydroxide Layer Behavior and Chemistry
2. Oxide Layer Radiolytic Gas Generation Resolution
3. Sealed and Vented System Episodic Breathing and Gas Generation Prediction
4. Performance of ASNF in Dry Storage
5. Oxide Layer Response to Drying
6. Surrogate Sample Preparation and Validation

These tasks are discussed below:

Task 1: Oxyhydroxide Layer Behavior and Chemistry

To discern ASNF performance over extended storage periods, understanding the behavior of oxide/oxyhydroxide films created during in-reactor operations and out-of-reactor storage with a focus on the effect of temperature on those films is critical. Task 1 characterizes the thicknesses and growth rates of oxide layers based on fuel history, tests material properties for the oxides prevalent on ASNF, and assesses both corrosion and radiolysis reactions in different oxide layers. The information created from Task 1 informs the modelling of storage systems (Task 3) and the drying of the spent fuel (Task 5).

Task 2: Oxide Layer Radiolytic Gas Generation Resolution

While Task 1 provides information on the amount of gas generated from thermal effects on or corrosion of the oxide/oxyhydroxide layer, Task 2 focuses on radiolysis of the oxide/oxyhydroxide layer and gaseous sources present within the storage canister. This task supports storage models (Task 3) with information about maximum gas generation rates.

Task 3: Sealed and Vented System Episodic Breathing and Gas Generation Prediction

Exchanges of reactive gases and heat with ambient air generated by episodic breathing in vented, unsealed storage canisters shifts the chemical equilibrium inside the canister and affects the radiolytic production of corrosive gases. Task 3 models the combined effects of episodic breathing in vented canisters in CPP-603 with the radiolytic gas generation on the aluminum cladding, oxide layers, canister, and other system components.These modeling results guide experimental designs in Tasks 1 and 2.

Task 4: Performance of ASNF in Dry Storage

To predict long-term integrity of stored ASNF, baseline information about the passive oxide/oxyhydroxide surface character of the fuel at various stages during its life cycle is needed. Task 4 physically inspects Advanced Test Reactor (ATR) fuel at the Idaho Nuclear Technology and Engineering Center in building CPP-603 to demonstrate ASNF peformance over the storage lifetime. At a minimum, visual inspection will be performed to validate concerns about corrosion and radiolytic phenomena and to verify storage conditions have not introduced new, unexpected behavior.

Beyond visual examination, the surface layer of various accessible parts of the fuel cladding may be sampled to compare to the as-stored dry to the post-irradiation wet oxyhydroxide layers. Samples will only be taken from cladding and will not contain fuel meat. This part of the proposed action is in development. The Department of Energy, Idaho Cleanup Project, and INL are collaborating to develop the capability to perform this task. Further development of Task 4 scope could require revision of this EC.

To the extent possible, analytical evaluations will be coordinated with Savannah River National Laboratory (SRNL) (Task 6) to allow consistent comparisons between SRNL and INL materials.

At the end of reactor service, the end boxes are removed from each ATR element before transfer out of the ATR canal. Samples of aluminum cladding will be obtained from the end boxes. Sample analysis of fuel meat is not proposed. In addition, a tool designed for handling individual ATR fuel elements may be procured to allow handling of individual elements rather than baskets or canisters. Samples will be shipped to the Electron Microscopy Laboratory at the Materials and Fuels Complex for analysis.

Task 5: Oxide Layer Response to Drying
Task 5 analyzes the effects of drying ASNF on the development and composition of oxide layers. The underlying goal is to understand how different drying procedures (e.g., temperature, vacuum, forced helium) remove water in some of the oxide layers and the impact on those layers. The temperatures and oxide layers for analysis will be determined based on Task 1. Task 5 milestones are based on fiscal year 2018 funds and dependent on other information obtained from other the tasks. As such, no dates have been assigned to these milestones.

Task 6: Surrogate Sample Preparation and Validation
The proposed action requires use of laboratory grown surrogate materials. Validating that surrogate materials represent ASNF oxyhydroxide layer composition (e.g., gibbsite, bayerite, and boehmite) is critical to verify results of proposed investigations are representative of actual ASNF. This task includes 1) characterization of the oxide/oxyhydroxide layers on unirradiated aluminum samples shipped to Idaho National Laboratory from SRNL and 2) preparation and characterization of representative surrogate materials for use in other tasks.

Sample components are not considered waste until they are no longer needed. It is anticipated that all sample materials will be consumed during analysis. However, any waste generated from sample components will be low level radiological waste (LLW). Project activities do not involve irradiated fuel materials. The LLW would be disposed at the Nevada National Security Site (NNSS). This material will be disposed similar to other DOE-owned irradiated materials and experiments using current INL waste streams and supported under DOE O 435.1, Att. 1, Item 44.

Storing used nuclear fuel and research and development for used nuclear fuel management is covered by DOE's Programmatic Spent Nuclear Fuel (SNF) Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (EIS) 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 (February 1996). The analyses include impacts related to storage of, and research and development related to used nuclear fuel at INL (see Tables 3.1 of the SNF Record of Decision (May 30, 1995) and Table 1.1 of the Amended Record of Decision [February 1996].

The proposed action has the potential to generate low-level radioactive waste LLW. The LLW will be disposed at the NNSS. The environmental impacts of transferring LLW from INL to the NNSS were analyzed in the 1996 Nevada Test Site EIS (DOE/EIS-0243) and supplemental analysis (SA) (DOE/EIS-0243-SA-01) 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. The SA considers additional waste streams, beyond those considered in the 1996 NTS EIS, which may be generated at or sent to the NNSS for management.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Particulate and gaseous emissions are not expected to increase due to the proposed research. The proposed action is encompassed by the operating requirements and processes identified in SAR-153 and the source term in SAR-153 Chapter 12 "Radiation Protection." ATR radionuclide emissions are sampled and reported in accordance with Laboratory Wide Procedure (LWP)-8000 and 40 CFR 61 Subpart H. All radionuclide release data (isotope specific in curies) directly associated with the proposed action will be calculated and provided to ATR Programs Environmental Support organization.

Project activities have the potential for small amounts of radioactive material release through the EML HEPA filtered ventilation system. These emissions are consistent with the ongoing mission of the EML, and would not be considered a new source or modification.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

Section 106 of the National Historic Preservation Act (NHPA) requires the review of any proposed activity or project to determine if historic properties may be affected by the undertaking. The CRMO will conduct a Cultural Resource Review (CRR) for the proposed research activities.

Generating and Managing Waste

It is anticipated that all sample materials will be consumed during analysis. However, any waste generated from sample components (aluminum cladding material only) will be LLW from aluminum cladding materials and hardware.

Waste Generator Services (WGS) manages all waste for appropriate disposition.

Pollution prevention/waste minimization will be implemented where economically practicable to reduce the volume and/or toxicity of waste generated.

Releasing Contaminants

Project activities involve the use of chemicals. Although not anticipated, there is a potential for spills when using chemicals or fueling equipment. In the event of a spill, notify the 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 material generated from project would be reused and recycled where economically practicable.

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, 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 Nevada Test Site and Off-Site Locations in the State of Nevada (DOE/EIS-0243) and supplemental analysis (SA) (DOE/EIS-0243-SA-01).

Justification: Project activities are consistent with 10 CFR 1021, Appendix B, 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); 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."

R&D activities are further encompassed by DOE/EIS-0203, DOE/EIS-0203-SA-01, and DOE/EIS-0203-SA-02 and the Amended ROD (1996). DOE/EIS-0200 made the Nevada National Security Site available to all DOE sites for low-level waste disposal, and DOE/EIS-0243 and ROD (65 FR 10061, February 2000) analyzed the impacts of transportation from the INL and disposal at the Nevada National Security Site.

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: 5/13/2020