DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-20-064

SECTION A. Project Title: Nuclear Materials Discovery and Qualification Initiative Testing and Characterization

SECTION B. Project Description and Purpose:

Nuclear Materials Discovery and Qualification Initiative Testing and Characterization Environmental Compliance Permit Work-Scope Description

The Nuclear Materials Discovery and Qualification Initiative (NMDQi) is focused on implementing advanced materials science research and development methods to improve the rate of discovery and qualification of novel materials for nuclear applications. The testing and characterization component of NMDQi will include three thrusts: irradiation of novel materials, multi-modal non-destructive characterization, and multi-modal semi-destructive characterization. The three primary tasks of the NMDQi testing and characterization are described below:

ANCERS:

ANCERS is an integration of three instrument techniques for non-destructively characterizing solid materials. The three techniques include neutron radiography (nRAD), gamma emission tomography (GET), and x-ray computed tomography (XCT). These instruments all currently exist in some form at INL. In the case of GET, a new apparatus will need to be built. This effort will initially take place at INL Research Center (IRC) where a new benchtop GET will be designed and built. Once built, the instrument will be transferred to MFC where it will be installed in either the east or west radiography tower. Once installed in the radiography tower, the GET will be used in coordination with existing nRAD and XCT systems. Fabrication of components will be done at the IRC machine shop as needed.

HYDRA-L:

This task will design, build, and install a continuous laser and pulsed laser spectroscopy instruments within the scanning electron microscopy (SEM) chamber of the Hydra SEM at IMCL at MFC. This will verify multiple sample testing and integration with imaging capabilities. Design, mockup, and testing will take place in IRC using the existing optics equipment. The design will eventually include the purchase of new lasers and other materials for the design to be installed within the SEM. The fabrication will take place at the IRC machine shop.

NMDQ-ISHA:

The irradiation basket, NMDQ-ISHA, is being designed in accordance with FOR-560. The NMDQ-ISHA experiments will seek to provide neutron irradiation of both fissile (i.e., fuel) and non-fissile (e.g., structural) materials within the Advanced Test Reactor (ATR). These experiments will utilize various geometries and non-experimental materials to produce irradiation conditions that will mimic the anticipated conditions that the experimental materials would experience in a reactor environment. All experiments will be contained within a double-encapsulated design in which both capsules are designed to ASME BPVC requirements. The capsule will also utilize high thermal conductivity molten metals such as sodium and indium to make thermal bonds between capsules and experiments. The irradiated experimental materials will then be characterized by both non-destructive and destructive methods in order to extract the necessary data to support fundamental understandings of materials for further material discovery and qualification.

Fissile materials:

NMDQ-ISHA experiments may include the following nuclides: U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, and Np-237. These nuclides are common for fresh, irradiated, and actinide bearing fuels. The fuels may exist in metal/alloy (e.g., U-Zr), ceramic (e.g., UO2, UC, or UN), or molten salt (e.g., UCl-NaCl) forms. In all cases, the fuels and associated fission products will be contained within a cladding (for solid fuel forms) or containment vessel (for molten fuel forms). Following irradiation in the Advanced Test Reactor (ATR), the NMDQ-ISHA capsules will be shipped from ATR to the Hot Fuels Examination Facility (HFEF) at the Materials and Fuels Complex (MFC).

Non-Fissile Materials:

Unlike drop-in experiments such as AFC, AFC-FAST, or ATF-1, NMDQ-ISHA is also designed to accommodate non-fissile material irradiation. The scope of this task is very broad and some-what undefined as one component of NMDQi is material discovery and so the exact knowledge of what those materials are is unknown. That being said, there are some soft bounding considerations as to what element may contribute to the yet to be determined materials. Those elements include Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Al, Zr, Nb, Mo, Pd, In, Sn, Sb, Hf, Ta, W, Pt, Au, and Pb. Many of these elements are commonly found in traditional alloys such as stainless steels and are common constituents to high entropy alloys (a material system of interest to NMDQi). These elements may be used in experimental components such as gamma-heating elements (e.g., W based components).

Fabrication and Assembly:

INL personnel at the Research and Education Campus (REC), MFC, and ATR Complex coordinate experiment fabrication, characterization, irradiation, and post irradiation examination (PIE). The project team designs, analyses, and fabricates experiment components at REC.

The North Holmes Lab (NHL) machine shop fabricates most NMDQ-ISHA experiment components, and MFC fabricates fuel specimens. MFC also assembles and inspects the final rodlet and capsule assemblies. If other laboratories fabricate and ship fuel to INL, this environmental compliance permit (ECP) will be revised.

MFC fabricates and characterizes fissile experiments and performs PIE on irradiated specimens. Non-fissile experiments will be fabricated at a variety of locations (e.g., university partners, INL facilities already listed within this document, or other partner laboratories) and will be assembled at MFC. The ATR irradiates NMDQ-ISHA experiments and assists in capsule assembly. Following assembly, NMDQ-ISHA capsules will be shipped to ATR using a Type A shipping container.

The project performs neutronic, structural, and thermal analyses, and prepares the Experiment Safety Assurance packages (ESAs) required for ATR experiment insertion. Operations Systems Engineering, ATR Facility Safety Engineering, and the Safety Operations Review Committee (SORC) review and approve the ESAs.

The drop-in NMDQ-ISHA capsules will be irradiated in ATR for multiple cycles in the inner A (IA) positions. Following irradiation, INL ships the capsules to MFC for PIE. Fueled experiments will be shipped to HFEF and non-fueled experiments may be shipped to HFEF or Sample Preparation Laboratory (SPL). Experiments will be shipped using GE-100 casks or another approved shipping container.

Post-Irradiation Examination:

Performance data from NMDQ-ISHA fissile experiments include irradiation growth and swelling, fission gas production, fission gas release fractions, fission product and fuel constituent migration, fuel phase equilibria, and fuel-cladding chemical and mechanical interaction. Performance data from NMDQ-ISHA non-fissile experiments include microstructure response to radiation, mechanical properties, thermal properties, and other data streams necessary to meet the needs of the NMDQi team. These data can be acquired from a variety of means and will be determined on a case by case basis.

After irradiation, INL ships the capsule assembly to HFEF or SPL at MFC for PIE. Some capsules may intermittently be removed from the experiment assembly and shipped to HFEF for neutron Radiography (nRAD) imaging then shipped back to the ATR for continued irradiation. An empty “dummy” capsule will be inserted in place of the removed capsule(s) if the NRAD imaging cannot be performed during the cycle outage. HFEF may transfer samples to the Analytical Lab (AL), Fuels and Applied Sciences Building (FASB), the Electron Microscopy Lab (EML) at MFC, and/or potentially other internal (INL) or external laboratories for additional PIE analysis, as necessary. Shipping material to other laboratories will require discussion with the PEL and this ECP will be revised as necessary. INL has not yet developed a PIE plan, but PIE falls under existing capabilities of HFEF. The following paragraphs discuss general operations performed in HFEF.

Cask Transfer from ATR to HFEF:

Following removal from ATR and after needed decay time in the reactor canal, each NMDQ-ISHA capsule would be loaded into a shipping cask for transfer to HFEF. HFEF routinely receives casks such as the GE-100 cask and uses standard procedures to mate the cask to the hot cell and open the cask.

Photo-visual Inspection:

After unloading from the shipping cask, INL visually inspects experiment exteriors using a digital camera via periscope or through a hot cell window to identify any damage or degradation.

Neutron Radiography:

Prior to disassembly, neutron radiography may be performed on the experiment to establish the general condition of fuel. Each experiment would be lowered beneath the HFEF main cell and positioned in a beam from the NRAD reactor to reveal experiment features.

Gamma Scanning:

Experiments may be examined by precision (isotopic) gamma scanning for information on both fission product migration and shifting of fuel compacts within the capsules.

Disassembly:

Experiments are disassembled to extract capsule components, including fuel. Fuel components from the irradiation capsules are photographed and measured. Some components are sent directly to the IMCL or other PIE facilities for analysis, some to the containment box for sectioning and mounting, and others to other instruments within HFEF (e.g., the a furnace for safety testing). Other hardware associated with disassembly have various exams done within HFEF and the PIE facilities.

Fission Gas Testing:

Fission gas testing is completed by placing irradiated fuel specimens in the gas assay sample and recharge (GASR) system to recover and quantify fission gases (notably Kr and Xe). Following counting, excess gases are exhausted out to the HFEF stack.

Waste Disposal:

In order to complete proposed work activities, it is necessary for the project to use the HFEF hot cell which contains both defense and nondefense related materials and contamination. Project materials may come into contact with defense related materials. It is impractical to clean out defense related contamination, and therefore, waste associated with project activities may be eligible for disposal at the Waste Isolation Pilot Plant (WIPP). NEPA coverage for the transportation and disposal of waste to WIPP are found in 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.

Packaging, repackaging, transportation, receiving, and 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 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 analysis includes those impacts related to transportation to, storage of, and research and development related to used nuclear fuel at the 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].

While the research test specimens described in the ECP are not spent nuclear fuel, they are similar in environmental hazards, except the test specimens contain less radiological material than a normal spent nuclear fuel shipment. Therefore, the potential environmental impact of transportation of the test specimens can be conservatively estimated to be equal to or less than a spent nuclear fuel shipment. The potential for transportation accidents was analyzed in the 1995 PSNF EIS (Section 5.1.5 and Appendix I-5 through I-10).

Finally, the record of decision for the 1995 PSNF EIS, DOE determined and stated, "the evaluated potential impacts resulting from all alternatives were found to present no significant risk to potentially affected populations." Based on DOE's statement for the entire DOE SNF program, the proposed action would not have the potential for significant impact or have any unique or unknown risks.

Proposed testing for NMDQ-ISHA is expected to begin in 2022 (171A cycle of ATR) and will run to at least 2027.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

The proposed action has the potential to generate radiological and chemical emissions from irradiation in ATR and the destructive and non-destructive PIE at HFEF. Air emissions are anticipated to be minor, and concentrations would not exceed the current monitored air emissions from these facilities. An Air Permit Applicability Determination (APAD) is required for any work or project causing radiological emissions that aren't covered under an existing APAD.

The ATR irradiation activities are not modifications in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H. ATR radionuclide emissions are sampled and reported in accordance with Laboratory Wide Procedure (LWP)-8000 and 40 CFR 61 Subpart H. All experiments will be evaluated by Environmental Support and Services staff. All radionuclide release data (isotope specific in curies) directly associated with this proposal will be calculated and provided to the Environmental Support organization.

The irradiated specimens will be delivered to the MFC HFEF for disassembly and then undergo routine PIE. All radionuclide release data associated with the PIE portion of this experiment will be recorded as part of the HFEF continuous stack monitor. The PIE examination in HFEF is not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H.

In 2018, the effective dose equivalent to the offsite maximally exposed individual (MEI) from all operations at the INL Site was calculated as 1.02 E-02 mrem/yr, which is 0.10% of the 10-mrem/yr federal standard and was calculated using all sources that emitted radionuclides to the environment from the INL site. The additional increment in emissions from the proposed action would not significantly change the total site-wide MEI dose. Therefore, the emissions are bounded by the analysis in the 1995 EIS, which estimated the annual cumulative doses to the maximally exposed worker, offsite maximally exposed individual (MEI), and the collective population from DOE's decision to implement the preferred alternative (DOE/EIS-0203). The potential air emissions and human health impacts associated with the proposed action would be smaller than and are bounded by the impacts presented in the 1995 EIS.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

The ATR Reactor Building (TRA-670) is over 50 years old. No structural or aesthetic changes will be made to the building.

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 800 cubic centimeters (conservative estimate). 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...".

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

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 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).

Final Environmental Assessment and Finding of No Significant Impact 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, December 2011)

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."

Transportation, receiving, and storing used nuclear fuel, as well as, 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 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 analysis includes those impacts related to transportation to, storage of,and research and development related to used nuclear fuel at the 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 EIS limits the number of shipments to the INL, and the proposed activities would fall within the limits of the EIS.

The potential for transportation accidents has already been analyzed in the SNF EIS (Section 5.1.5 and Appendix I-5 through I-10). NEPA coverage for the transportation and disposal of waste to WIPP are found in 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 low level waste from the INL to the Nevada National Security Site 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, that may be generated at or sent to the Nevada National Security Site for management.

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).

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: 08/24/2020