DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-19-034

SECTION A. Project Title: Advanced Fuels Campaign Fission Accelerated Steady-State Test (AFC-FAST)

SECTION B. Project Description and Purpose:

The Fuel Cycle Research and Development (FCRD) program aims to recycle used nuclear fuel and reduce the time-scale for managing high-level nuclear waste. The FCRD enables safe, secure, economic, and sustainable nuclear energy expansion while reducing proliferation risks. The program focuses on long term, science-based technology research and development (R&D) having the potential to change management of the nuclear fuel cycle and nuclear waste.

The FCRD Advanced Fuels Campaign (AFC) at Idaho National laboratory performs R&D for advanced nuclear fuel forms (including cladding) to:

- Enhance the performance and safety of the nation's current and future reactors
- Enhance proliferation resistance of nuclear fuel
- Effectively utilize nuclear energy resources
- Address the longer-term waste management challenges.

The AFC Fission Accelerated Steady-State Test (AFC-FAST) experiments aim to increase irradiation testing productivity by accelerating burnup in irradiation experiments. FAST uses reduced diameter rodlets to reduce irradiation times. The proposed action also supports developing future fast reactor fuels. The FAST experiments focus first on metallic fuel forms then expands to include ceramics. Either form may contain the following nuclides: U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, and Np-237. Following irradiation in the Advanced Test Reactor (ATR), the FAST capsules will be shipped from ATR to the Hot Fuels Examination Facility (HFEF) at the Materials and Fuels Complex (MFC).

FAST capsules are drop-in fueled irradiation experiments consisting of reduced diameter rodlets that can be taken to higher power densities while maintaining prototypical temperatures so that irradiation times can be significantly reduced. Initial testing focuses on metallic fuels for sodium-cooled fast reactors, however the same approach includes accelerated testing of Mixed-Oxide (MOX) fuels for fast reactors, carbide and nitride fuels for gas-cooled reactors, and ceramic fuels for advanced light water reactors. FAST experiments are irradiated in the ATR OA positions A-9 through A-12 and ATR SI positions I-22 through I-24 using the AFC-OA and ATF-1 SI basket hardware designs.

Performance data from FAST 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.

Fuel compositions for individual FAST experiments will be determined after completion of neutronics analysis for each experiment. The final fuel composition targets will be identified in individual Irradiation Test Matrices documented in both the neutronics analysis Engineering Calculations and Analysis Report (ECAR) and the fabrication and assembly specification document.

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 designs, analyzes, and fabricates experiment components at REC. MFC fabricates and characterizes experiments and performs PIE on irradiated specimens. The ATR irradiates FAST experiments and fabricates experiment baskets and related components.

The North Holmes Lab (NHL) machine shop fabricates most FAST 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 checklist (EC) will be revised. Experiment capsules each contain one fueled rodlet suitable for ATR irradiation. The project fabricates and assembles drop-in containment pressure boundary experiment capsules meeting the intent of ASME Section III, Class 1. Personnel at MFC validate fuel compositions and forms prior to insertion in the ATR.

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

The drop-in FAST irradiation capsules will be irradiated in ATR for multiple cycles, in both the OA and SI positions. OA baskets hold one set of vertically stacked capsule assemblies per ATR-OA position. SI baskets have three channels and contain three sets of vertically stacked capsule assemblies, with one basket assembly per ATR-SI position. Following irradiation, INL ships the capsules to HFEF for PIE.

Following fabrication, INL ships FAST fuel assemblies from MFC to ATR using a Type-A shipping container. Following irradiations, INL ships experiments using the GE-100 cask or another approved shipping container. Prior to shipment, INL determines the source term and heat load for the shipment. coordinated by INL personnel.

INL removes capsules from the ATR core during scheduled ATR outages as needed to replace the cadmium baskets, replace flux-wire monitors, and accommodate basket reconfigurations. INL removes capsules from ATR once specific burnup is achieved and stores capsules in the ATR Canal until the capsules have cooled down.

After irradiation, INL ships the capsule assembly to HFEF at MFC for PIE. Some capsules may intermittently be removed from the experiment assembly and shipped to HFEF for NRAD radiography 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) or 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 requires revising this EC.

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 to support PIE:

Cask Transfer from ATR to HFEF:
Following removal from ATR and after needed decay time in the reactor canal, each AGR test train 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 to the Analytical Laboratory for analysis, some to the containment box for sectioning and mounting, and others to the FACS furnace for safety testing. Other hardware associated with disassembly have various exams done within HFEF and the Analytical Laboratory.

Safety Testing:
Safety testing is completed by placing irradiated fuel specimens in the high temperature furnace system in HFEF and heating the fuel while measuring the release of metallic and gaseous fission products as a function of time. A high purity helium sweep gas is metered past the heated fuel sample in the furnace and is routed to a fission gas monitoring system which cryogenically traps the Kr and Xe gases for radioactive emissions counting. Following counting, the Kr and Xe gases are exhausted out to the HFEF stack.

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 will 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 EC 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 FAST is expected to begin in March 2020 (168B cycle of ATR) and will run to at least 2025.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Experiment irradiation and PIE will be performed at the ATR and MFC facilities. Air emissions would include minor amounts of radionuclides and toxic air pollutants. The irradiation in the ATR 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. 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 ATR Environmental Support and Services staff, prior to insertion in the ATR. All radionuclide release data (isotope specific in curies) directly associated with this experiment will be calculated and provided to ATR Programs Environmental Support organization.

The irradiated specimens will be delivered to the MFC HFEF for disassembly and then undergo routine PIE before being sent to the Analytical Lab for analysis. All radionuclide release data associated with the PIE portion and analysis of this experiment will be recorded as part of the HFEF and Analytical Lab continuous stack monitors and provided to Programs Environmental Support organization. The PIE examination in HFEF and the analysis completed in the Analytical Lab 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. Releases of radioactive airborne contaminants from these processes are not expected to result in an increase to the annual dose to the Maximum Exposed Individual (MEI).

For both ATR and MFC, an APAD will be completed documenting that emissions do not constitute a modification to the facility.

All radionuclide release data associated with packaging compacts described in Revision 1 will be recorded as part of the HFEF continuous stack monitor and provided to Program Environmental Support organization. Packaging 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. Releases of radioactive airborne contaminants from these processes are not expected to result in an increase to the annual dose to the Maximum Exposed Individual (MEI).

Generating and Managing Waste

Total project waste volume from the research and development performed on the used fuel feedstock is projected to be less than 1 m^3. The BEA Waste Management Program and MFC Waste Generator Services (WGS) staff would be consulted for characterization and disposition pathways determination for the generated wastes.

Experiment disassembly creates relatively small amounts of radioactive waste for disposal.

Cutting, slicing, grinding, and polishing activities create small volumes of remote handled radioactive wastes. Wastes include the grinding and polishing residues and the unused portions of the fuel compacts.

Project and HFEF personnel work with Waste Generator Services (WGS) to properly manage and store samples. Normally, storage of samples is limited to one year in accordance with company procedures. After completion of research activities, storage of samples greater than one year will require project and/or HFEF personnel to annually review sample inventory. Project and/or HFEF personnel will notify the Program Environmental Lead (PEL) for post-research samples exceeding one year in storage and provide updates on sample disposition.

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 PEL. If the PEL 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 materials will be reused and recycled where economically practicable. All applicable waste will be diverted from disposal in the landfill where conditions allow.

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 for the Multipurpose Haul Road Within the Idaho National Laboratory Site (DOE/EA-1772, 2010).

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.

The impacts of transporting spent fuel, special nuclear materials, and research fuels between MFC and other INL Site facilities using the Multi-Purpose Haul Road were analyzed Final Environmental Assessment for the Multipurpose Haul Road Within the Idaho National Laboratory Site (DOE/EA-1772).

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: 5/30/2019