DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-16-093

SECTION A. Project Title: Nuclear Science User Facilities (NSUF) University of Central Florida Experiment

SECTION B. Project Description and Purpose:

Understanding depleted uranium (DU)-Zr and DU-Mo based metallic fuel behavior with low fluence irradiation testing is needed. The purpose of the proposed action is to obtain the needed data for low fluences of metallic fuels. The proposed action focuses on low fluence irradiations utilizing the Hydraulic Shuttle Irradiation System (HSIS) and a small B position within the Advanced Test Reactor (ATR). It is known that the changes that lead to fuel degradation start at very low burn-up (e.g., <0.9%). The proposed action would examine changes in metallic fuels from low fluence, including defect formation, fission product nucleation, constituent redistribution and microstructural degradation. Three fluences (0.01, 0.1, and 1.0 dpa) and seven temperatures (ranging from 150° to 800°C) would be explored with various exposure times. Fuel for the proposed action would be manufactured from DOE-owned depleted uranium.

Low fluence experiments have a cross-cutting relevance to both the Advanced Fuel Cycle Initiative (AFCI) and the Material Management and Minimization (M3) programs. This research would provide critical flow fluence data where none is currently available. These data would serve to elucidate early microstructural development and mechanisms, as well as provide critical data for models under development in both programs. The goal of the AFCI is to develop fuels for the Generation IV Nuclear Energy Systems (Gen IV). These fuel systems are intended to reduce the volume of high-level radioactive waste, reduce the radiotoxicity of the repository, and utilize the energy content of spent nuclear fuel. New metallic fuel pins are under consideration for the actinide transmutation mission in future fast reactors. As AFCI undertakes a new metallic fuel development program to investigate alloys appropriate for the actinide transmutation mission, alloys substantially different from those developed as part of past U.S. breeder reactor programs, the experimental infrastructure of fast test reactors and post-irradiation examination (PIE) capabilities are more limited. Therefore, there is an effort aimed at developing a new fuel performance code that is science-rooted with a design-capable microstructural model that does not require empirical parameters. It is thought that this model can later serve to design fuel alloys for AFCI's actinide transmutation mission in fast reactors and can identify critical fuels for experimental performance evaluation (i.e., critical function to reduce irradiation experiments required for validation).

This proposed action is focused on providing key, in-pile data necessary to support this effort, either as input to the model or for validation purposes. Samples to be irradiated include prefabricated transmission electron microscope (TEM) disks, diffusion couples and foil cutouts.

The following specific activities would be performed at the Idaho National Laboratory (INL):

- Designing and developing experiment
- Analyzing neutronic, thermal/hydraulic, and structure of experiment components
- Marking specimens, encapsulating specimens, machining and welding capsule end caps
- Preparing the Experiment Safety Assurance Package (ESAP) and obtaining approval of the package, allowing experiment receipt at ATR, reactor insertion, irradiation, discharge, storage in the canal, and shipping
- Shipping the experiment assemblies from the assembly facilities to ATR
- Receiving the experiment assemblies at ATR
- Inserting the experiments in the ATR and irradiating to specified conditions
- Handling and reconfiguring experiment as needed
- Removing experiments from ATR and storing in the ATR canal during cooling
- Shipping the irradiated experiment assemblies to the Hot Fuels Examination Facility (HFEF) or other appropriate facility located at Materials and Fuels Complex (MFC)
- Focusing post-irradiation examination (PIE) activities on early defect formation and evolution of phase constituents.

Experiment assembly, irradiation, and PIE would be a coordinated effort among INL personnel located at the Research and Education Campus (REC), MFC, and ATR Complex. INL would perform all neutronic, structural, and thermal/hydraulic analyses, and would prepare the ESAP required for ATR experiment insertion.

Experiment assemblies would be shipped to ATR using approved shipping containers.

The experiment assemblies would be removed from ATR when specified irradiation test conditions have been met then stored in the ATR canal area until the capsules have cooled sufficiently to allow safe handling and transportation. The experiment assemblies would then be shipped to HFEF or another appropriate facility at MFC for PIE. Shipment from ATR Complex to the hot Fuels Examination Facility (HFEF), or another appropriate facility at MFC, would be made using a Type B container approved for shipment under a transport plan. Capsule disassembly would be completed at HFEF or another appropriate facility. HFEF or the other receiving/disassembly facility may transfer samples to the other examination laboratories at MFC or other national laboratories or universities for additional PIE as necessary.

The sample sets for the three stages of irradiation (Table 1, 2, and 3) have been down-selected from the original University of Central Florida (UCF) proposal. This sample set was selected based on specimen availability and current capabilities for handling fissile material irradiations in the HSIS.

This environmental checklist would be revised, as necessary, to capture scope, environmental aspects and work activities associated with future irradiations and sample sets.

The UCF Hydraulic Shuttle Irradiation System (HSIS) titanium shuttle capsules and internals would be fabricated by INL. UCF and MFC would fabricate the specimens according to experiment specifications.

HSIS capsule and internals manufacturing activities would be performed at the North Holmes Laboratory (NHL) and/or ATR Machine Shop and assembled at INL Research Center (IRC). Specimens would be fabricated at MFC. No new equipment would be purchased.

Table 1. Specimen matrix for the first stage of the UCF experiment.

			TEMs									Square Cutouts	
Fluence (dpa)	Capsule ID	Design temp (°C)	DU TEM disc	Zr TEM Disc	Mo TEM Disc	DU-10Zr TEM disc	DU-15Zr TEM disc	DU-20Zr TEM disc	DU-7Mo TEM disc	DU-10Mo TEM disc (foil)	DU-10Mo TEM disc (cast)	DU-10Mo Plate w/Zr	DU-7Mo Plate
0.01 (HSIS)	UCF-1	150	1		1				1	1	1	1	1
	UCF-7	250	1		1				1	1	1	1	1
	UCF-2	350	1		1				1	1	1	1	1
	UCF-6	500	1	1	1	1	1	1					
	UCF-3	600	1	1	1	1	1	1					
	UCF-5	700	1	1	1	1	1	1					
	UCF-4	800	1	1	1	1	1	1					
0.1 (HSIS)	UCF-8	150	1		1				1	1	1	1	1
	UCF-14	250	1		1				1	1	1	1	1
	UCF-9	350	1		1				1	1	1	1	1
	UCF-13	500	1	1	1	1	1	1					
	UCF-10	600	1	1	1	1	1	1					
	UCF-12	700	1	1	1	1	1	1					
	UCF-11	800	1	1	1	1	1	1					

Table 2. Specimen matrix for the second stage of the UCF experiment.

			Diffusion Couples								
Fluence (dpa)	Capsule ID	Design temp (°C)	DU vs. Al bulk	DU-10Mo vs. Al bulk	DU vs. Zr bulk	DU vs. Fe bulk	DU vs. Fe thin film	DU vs. Fe-15Cr bulk	DU vs. Fe-20Cr thin film	DU vs. Fe-15Cr-20Ni bulk	DU vs. Fe-20Cr-20Ni thin film
0.01 (HSIS)	UCF-22	150	1	1	1						
	UCF-27	250	1	1	1						
	UCF-23	350	1	1	1	1	1	1	1	1	1
	UCF-26	500			1	1	1	1	1	1	1
	UCF-24	600			1	1	1	1	1	1	1
	UCF-25	700			1	1	1	1	1	1	1
0.1 (HSIS)	UCF-28	150	1	1	1						
	UCF-33	250	1	1	1						
	UCF-29	350	1	1	1	1	1	1	1	1	1
	UCF-32	500			1	1	1	1	1	1	1
	UCF-30	600			1	1	1	1	1	1	1
	UCF-31	700			1	1	1	1	1	1	1

Table 3. Specimen matrix for the third stage of the UCF experiment.

			TEMs									Square Cutouts	
Fluence (dpa)	Capsule ID	Design Temp (C)	DU TEM disc	Zr TEM Disc	Mo TEM Disc	DU-10Zr TEM disc	DU-15Zr TEM disc	DU-20Zr TEM disc	DU-7Mo TEM disc	DU-10Mo (foil) TEM disc	DU-10Mo (cast) TEM disc	DU-10Mo Plate w/Zr	DU-7Mo Plate
1.0 (Drop-in)	UCF-15	150	1		1				1	1	1	1	1
	UCF-21	250	1		1				1	1	1	1	1
	UCF-16	350	1		1				1	1	1	1	1
	UCF-20	500	1	1	1	1	1	1					
	UCF-17	600	1	1	1	1	1	1					
	UCF-19	700	1	1	1	1	1	1					
	UCF-18	800	1	1	1	1	1	1					

Diffusion Couples											
Fluence (dpa)	Capsule ID	Design temp (C)	DU vs. Al bulk	DU-10Mo vs. Al bulk	DU vs. Zr bulk	DU vs. Fe bulk	DU vs. Fe thin film	DU vs. Fe-15Cr bulk	DU vs. Fe-20Cr thin film	DU vs. Fe-15Cr-20Ni bulk	DU vs. Fe-20Cr-20Ni thin film
1.0 (Drop-in)	UCF-34	150	1	1	1						
	UCF-39	250	1	1	1						
	UCF-35	350	1	1	1	1	1	1	1	1	1
	UCF-38	500			1	1	1	1	1	1	1
	UCF-36	600			1	1	1	1	1	1	1
	UCF-37	700			1	1	1	1	1	1	1

Characterization of experiment materials to support the UCF specimens would be conducted at external laboratories and various facilities at MFC including, but not limited to, the Electron Microscopy Laboratory, Fuels and Applied Sciences Building, and the Analytical Laboratory.

Upon discharge of each experiment from the ATR, the UCF experiments would be cooled until radiation levels are reduced to safe levels for handling and transporting to MFC for analyses. The capsule assemblies would be shipped to HFEF or another appropriate facility at the MFC for capsule disassembly. The post-irradiation examinations may occur at MFC, other national laboratories, and/or universities. The PIE activities would focus on early defect formation and evolution of phase constituents utilizing optical metallography scanning electron microscopy (SEM/EDS/WDS), transmission electron microscopy (TEM/EDS), and visual examination.

Incidental waste associated with experiment activities would be managed per the facility in which it is created. Experiment components would not be considered waste until they are no longer needed for these experiments as designated by the Experiment Manager (EM). All waste associated with the proposed action would be radiological or cold waste as determined per facility criteria. The project would involve non-destructive analyses of the experiments, and the depleted uranium would not be waste. Experimental disks would be catalogued and retained. Waste would likely be the titanium capsules (39 capsules approximately 2" tall and 5/8" diameter), stainless steel springs, zirconia spacers and insulators, silicon carbide temperature monitors, fluence monitors (metallic wires within vanadium capsules), and aluminum or titanium fixtures. The capsules, springs, spacers, insulators, and fixtures would likely be considered low level waste and be disposed at the Nevada National Security Site (NNSS).

Project activities described in this environmental checklist will use existing facilities at MFC and ATR and proposed activities are consistent with current facility operations.

Packaging, repackaging, transportation, receiving, and storing used nuclear fuel and R&D 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 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 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.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

ATR and HFEF were constructed prior to the Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H, so are considered "Grandfathered Facilities." Until these facilities are "modified", (i.e. means any physical change in, or a change in the method of operation of an existing facility which increases the amount of a regulated pollutant), they remain grandfathered. If an increase in production rate does not exceed the air emissions source operating design capacity, increase hours of operation, or use alternative raw materials, then the increase in production is not considered a change in method of operation--unless more restrictive production rates or hours of operation are specified in a permit, or the use of alternative raw materials is specifically prohibited in a permit.

Particulate and gaseous emissions are not expected to increase due to this experiment. 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 experiments are 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.

HFEF is a hot-cell complex designed for the preparation and examination of irradiation experiments in support of a wide variety of programs and process demonstrations. It is anticipated that the potential radiological releases to the Main Cell from this project would be consistent with other in cell processes performing macro- and microanalysis. The facility would control particulate emissions by HEPA filtration and monitor emissions using a continuous emission monitoring system. It is expected that particulate and gaseous emissions from operations would not result in an emissions increase HFEF. This work is encompassed by the HFEF source term that was derived from DSA- 003-HFEF Rev 6, Chapter 3 "Radiological Inventory" and thus an APAD is not required at this time.

No air emissions are expected during fresh fuel examinations at MFC or at in-town facilities.

Generating and Managing Waste

Project activities would likely result in the generation of small amounts of industrial waste. Waste would likely be the titanium capsules (39 capsules approximately 2" tall and 5/8" diameter), stainless steel springs, zirconia spacers and insulators, silicon carbide temperature monitors, fluence monitors (metallic wires within vanadium capsules), and aluminum or titanium fixtures. The capsules, springs, spacers, insulators, and fixtures would likely be considered low level waste and be disposed at the NNSS. The project would involve non-destructive analysis of the experiments and the depleted uranium would not be waste. Experimental disks would be catalogued and retained.

Releasing Contaminants

All chemicals utilized by the project would be managed in accordance with laboratory procedures.

Using, Reusing, and Conserving Natural Resources

All materials 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"
Final Environmental Assessment (EA) for the Consolidation and Expansion of Idaho National Laboratory Research and Development at a Science and Technology Campus and Finding of No Significant Impact (DOE/EA-1555, March 2007)

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."

The impacts of conducting radiological research at INL's in-town facilities were analyzed in DOE/EA-1555 (March 2007) section 4.2.2.

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 Jack Depperschmidt, DOE-ID NEPA Compliance Officer on: 8/4/2016