DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-16-032

SECTION A. Project Title: European Mini-Plate Irradiation Experiment (EMPIRE) Capsules

SECTION B. Project Description and Purpose:

The European Mini-Plate Irradiation Experiment (EMPIRE) at Idaho National Laboratory (INL) includes fabrication and inspection, characterization, irradiation and post-irradiation examination (PIE) of monolithic and dispersion experimental fuel plates to support fuel development for the European reactor conversion from highly-enriched uranium (HEU) to low-enriched uranium (LEU). The proposed action is supported by the United States (U.S.) Department of Energy (DOE)/National Nuclear Security Administration (NNSA) Office of Materials Management and Minimization (MMM) European Reactor Conversion Program in collaboration with the Highly Enriched European Reactors Action for Conversion in a Low Enriched Solution (HERACLES) consortium. EMPIRE is not considered a qualification test for regulatory acceptance because it will help to determine which fuel system should be selected for more comprehensive testing in subsequent qualification campaigns.

Project activities described in this environmental checklist (EC) will use facilities at the Advanced Test Reactor (ATR) Complex, the Research and Education Campus (REC), and the Materials and Fuels Complex (MFC) consistent with current facility operations. Research and development activities associated with the EMPIRE experiment include experiment design, fabrication, irradiation, characterization and PIE.

The following describes each phase in more detail:

Management: Managing day-to-day execution of experiment activities, tracking progress, schedule and cost would occur primarily at REC facilities, but could also take place at ATR and MFC. Management of the entire life-cycle of the experiment includes management and disposal of waste. It is anticipated that most would be generated and dispositioned during experiment execution. However, some waste will be dispositioned upon project completion.

Design: Conceptual, preliminary and final stages of the experiment design would take place at REC facilities. The experiment will be designed to accommodate up to 48 mini-plate test specimens for irradiation (approximately 1 X 4-inch plates). Out of these 48 plates, 4 will be monolithic fuels and the rest dispersion fuels. In addition to plates designated for irradiation, 22 archive and 12 substitute mini-plates will be manufactured for the experiment. All plates will contain Low Enriched Uranium (LEU). Each dispersion plate will contain approximately 6.4 g U and 1.3 g of U235. Each monolithic plate will contain approximately 8 g U and 1.6 g U235. DOE would take title of the mini-plates in France and is responsible for shipping the mini-plates to INL.

Fabrication: Experimental fuel plates for the EMPIRE irradiation tests would be fabricated at Argonne National Laboratory and AREVA (France). The fuel plates intended for irradiation would be inspected and assembled into capsules at the Fuels and Applied Science Building (FASB) at MFC-787. After inspection, the fuel plates would be transported to ATR for irradiation. Fabrication of experiment support equipment, if necessary, would take place at fabrication facilities at REC, MFC or ATR.

Irradiation: Irradiation activities include preparation of the Experiment Safety Analysis (ESA) which documents compliance with the ATR Safety Analysis and Review (SAR) and Technical Safety Requirements and the preparation and issuance of irradiation documentation supporting experiment receipt, storage installation and irradiation. Plates would be irradiated in the ATR Critical facility to determine if the experiment can be irradiated in ATR within the bounds of the safety basis. Following the ATR Critical run, the experiment would be irradiated in ATR. Other related work may be undertaken to install experiment support equipment such as handling tools and inspection equipment. This phase also includes experiment cooling in the canal and shipping activities to MFC.

Characterization: A set of archive plates fabricated as described above will undergo fresh fuels characterization at various MFC facilities and possibly REC facilities to determine the properties of the plates in their unirradiated condition. This would establish the basis for understanding the performance or changes of plates during irradiation. During this phase, some work may be undertaken to develop and validate characterization techniques and to design, qualify and install characterization equipment. There are four types of characterization activities listed below:

1. Thermophysical properties encompassing measurements such as laser flash diffusivity, differential scanning calorimetry, dilatometer and other techniques to capture thermal properties
2. Microstructural analysis to characterize the microstructure utilizing microscopy such as optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), focused ion beam (FIB) and electron probe micro-analysis (EPMA) and x-ray diffraction
3. Physical and mechanical property measurements including density, micro-hardness, macro-hardness and other material strength tests performed no mechanical testing apparatus
4. Separate-effects testing encompasses a variety of measurements of materials under various test conditions such as heat treatments to determine phase changes and experiments to determine diffusion characteristics of certain elements into other materials.

PIE: After irradiation, the plates would be shipped to MFC PIE at the Hot Fuels Examination Facility (HFEF, MFC-785). PIE provides essential data on fuel irradiation performance. The following PIE activities would be conducted at HFEF:

1. Visual examination - Visual examinations are nondestructive examinations performed in HFEF to identify anomalies, changes, or defects that may have occurred during irradiation or shipping. Examinations are performed using a telephoto lens and camera and taking pictures through the hot cell window.

2. Disassembly Modeling - Disassembly is a nondestructive examination that removes the fuel plates from the experiment capsule.

3. Gamma Scanning - Gamma scanning is a nondestructive examination of the fuel plates where the experimental plates are scanned using the precision gamma scanner (PGS) in the transverse and axial directions. Results are used to determine the relative 2-D fission density distribution over a plate.

4. Immersion Density - Immersion density is a nondestructive examination of the fuel plates that provides fuel swelling data values for the entire plate.

5. Eddy Current (Oxide) - Eddy current measurements are nondestructive and are taken to estimate oxide thickness on fuel plate cladding.

6. Profilometry - Profilometry is nondestructive and is used to determine local fuel swelling.

7. Neutron Radiography Reactor (NRAD) - Neutron radiography is nondestructive and performed to assist in locating fuel zone and verifying integrity of the fuel meat.

8. Metallography - Metallography is a qualitative and quantitative measure. This is a destructive examination of irradiated plates and requires sectioning and mounting small pieces of the irradiated fuel plate.

9. Microhardness - Microhardness testing is a destructive examination of the fuel plates requiring sectioning and mounting small pieces of the irradiated fuel plate. This testing is completed using a system installed in the HFEF Metallographic (MET) box.

10. Blister Anneal Testing - Blister anneal testing is a destructive examination of irradiated plates and requires heating the fuel point to the point where the first failure threshold has been reached as indicated by blisters on the fuel plate surface. Blister anneal testing can be performed in furnaces with the capacity to reach a maximum of 550ºC.

11. Burn-up and SEM/TEM Sample Preparation - Sample preparation for isotopic burnup analysis and SEM/TEM microstructural characterization is a destructive examination of fuel plates and involves sectioning irradiated plates, packaging and transferring the materials to appropriate facilities for analysis.

12. Fission Product Release - Fission product release determinations require collection, measurement, and analysis of fission gases.

After PIE at INL, the irradiated sample segments and PIE remnants generated from this research and development activity would be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in HFEF or the Radioactive Scrap and Waste Facility (RSWF). Ultimate disposal of the irradiated sample segments and PIE remnants would be along with similar DOE-owned irradiated materials and experiments currently at MFC which are generated from other research and development activities. Categorizing this material as waste is supported under DOE Order (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...".

In addition, 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 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 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 Record of Decision (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.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Experiment irradiation and PIE will be performed at the ATR and MFC facilities (HFEF and Analytical Laboratory). 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. All radionuclide release data associated with the PIE portion of this experiment will be recorded as part of the HFEF continuous stack monitor and provided to Programs Environmental Support organization. The PIE examination in HFEF is not a modification in accordance with IDAPA 58.01.01.201 and 40 CFR 61 Subpart H. Releases of

radioactive airborne contaminants from this process are not expected to result in an increase to the annual HFEF dose to the Maximum Exposed Individual (MEI). Because this work is not considered a modification to an existing facility, no Air Permit Applicability Determination (APAD) is required.

Generating and Managing Waste

Small amounts of low-level, mixed low-level, industrial and hazardous waste may be generated. Irradiated sample debris and PIE waste are expected to generate research and development-related TRU waste and mixed TRU waste.

Forty-eight (48) plates will be irradiated (44 dispersion plates and 4 monolithic plates). The mass of the 48 plates is 0.723 kg. The total mass of the fueled plates and encasing hardware (capsules and spacers) is approximately 16 kg. After irradiation 15.156 kg will be removed and disposed of as low level waste (LLW). During irradiation, some of the 313.6 grams of uranium contained in the 48 plates will transmute and is calculated to generate 5.50E+08 nCi of transuranic activity. Post-irradiation destructive examination activities and cleanup is anticipated to generate approximately 3.0 kg of process and decontamination materials, resulting in a total transuranic waste mass of 3.7 kg or 0.01 m^3.

The balance of materials prepared for the EMPIRE experiment is 0.511 kg. These materials can be disposed of as LLW. Combined with the 15.156 kg of hardware to be removed from the irradiated plates, the total LLW mass is approximately 16 kg or 0.01 m^3. The total waste mass and volume for this experiment is 19.37 kg (0.02 m^3).

Releasing Contaminants

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

Using, Reusing, and Conserving Natural Resources

Reuse and/or recycle all materials where economically practicable. Divert applicable waste from disposal in the landfill where conditions allow. Practice sustainable acquisition, as appropriate and practical, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting, have recycled content, or are non-toxic or less-toxic alternatives (see http://www.sftool.gov/GreenProcurement).

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 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, Sept. 1997).

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 transporting and disposing of waste resulting from defense activities that was placed in retrievable storage pursuant to a 1970 Atomic Energy Commission policy (see Section 1.2) and TRU waste that was reasonably expected to be generated by ongoing activities and programs was analyzed in DOE/EIS-0026 (October 1980) and the Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant (SEIS-I) (DOE/EIS-0026-FS, January 1990).

NEPA coverage for the transportation and disposal of waste to WIPP are found in 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. DOE has analyzed TRU waste management activities in 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. (SEIS-II also includes potential transportation between generator sites.).

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: 4/4/2016