CX Posting No.: DOE-ID-INL-25-022

SECTION A. Project Title: Metallic Fuel Post-Irradiation Examinations on Legacy Material

SECTION B. Project Description and Purpose:

Historic or legacy fuel from EBR-II as well as additional historic fuels currently stored in the HFEF hot cell consist of metallic nuclear fuel at varying levels of burnup. Interest in new reactor types, and specifically the performance of the metallic fuels for power generating reactors, had driven funding to do research on these old fuels which were irradiated. The intent of this research is to support the eventual publication of topical reports to the NRC to qualify the metallic fuel for use in commercial power reactors.

The research takes place at several facilities at MFC: the Hot Fuels Examination Facility (HFEF), the Irradiated Materials Characterization Laboratory (IMCL), the Analytical Laboratory (AL), Structural Properties Laboratory (SPL), Electron Microscopy Laboratory (EML), Center for Advanced Energy Studies (CAES), and the FASB facility. All of the research in these labs are dictated and constrained to the capabilities of the facilities; new capabilities within these labs that support this research will be controlled using the existing improvement project process.

The scope of work that takes place during PIE on these metallic fuels in HFEF generally includes the following activities, using the capabilities and functionalities in the HFEF hot cell:

- Visual Examinations – either through-window or by using the Visual examination machine in the HFEF main cell.
- Precision Gamma Scanning – the PGS system in HFEF is used to collect gamma spectroscopy data from the fuel in the HFEF main cell.
- Contact profilometry – the Element Contact Profilometer or USHPRR Plate and Rodlet checker can be used to collect profilometry data.
- NRAD radiography – radiography or further irradiation of the material may occur in the NRAD reactor in HFEF.
- Fission Gas Puncture and Collection – fission gas volume, pressure, and a gas sample from the rods is collected by puncturing the cladding and extracting the gas in the GASR system in HFEF. The gas sample is stored in a sealed ampoule and sent to Pacific Northwest National Laboratory for Gas Mass Spectrometry using existing processes.
- Sectioning, mounting, polishing, sample prep – the capabilities in the HFEF containment Box are used to section the fuel and mount for metallography, and Microscopy, or to prepare for various other examinations including Laser Flash Analysis (LFA), Differential Scanning Calorimetry (DSC), mechanical testing specimens, or other examinations listed later.
- Optical Microscopy, metallography – the Metallography box houses a couple microscopes and a micro-indenter which may be used to characterize metallic fuels.
- Mechanical testing – though not well used yet, the program intends to begin mechanical testing of metallic fuel cladding specimens in the HFEF load frame.
- Fuel removal activities – to prepare mechanical testing specimens for cladding, it may be necessary to remove the fuel from the cladding. This may take place mechanically, at the HFEF in-cell mill, or by dissolution using existing processes in HFEF.
- Mill activities – specimen preparation for mechanical testing may be performed at the HFEF mill, as well as other milling activities to prepare specific geometries for other PIE exams. The mill is controlled by existing processes in HFEF.
- Waste – the waste from these examinations is handled using existing HFEF waste process for all research that takes place in the HFEF hot cell.

The scope of work that takes place during PIE on these metallic fuels for Advanced Characterization takes place in IMCL and EML, and generally includes the following activities, using the capabilities and functionalities in the containments:

- Sample preparation capabilities in the Shielded Sample Preparation Area (SSPA), glovebox and EML containments.
- Optical microscopy may be completed on the metallic fuel in the IMCL or EML.
- Scanning Electron Microscopy (SEM), Electron Dispersive Spectroscopy (EDS) and Electron Backscatter Diffraction (EBSD) – advanced characterization work will occur on the mounts produced from metal fuel in HFEF. These examinations may also utilize the SEM, Electron Dispersive Spectroscopy (EDS) and Electron Backscatter Diffraction (EBSD) analysis as part of the suite of analyses.
- Focused Ion Beam (FIB) use – the FIB capability will be used to polish, remove liftouts, and modify small samples from the metal fuel materials.
- Transmission Electron Microscopy (TEM) – TEM will occur on lamella pulled using the FIB capabilities.
- Atom Probe Tomography (APT) – Atom probe tomography may be used to analyze portions of this material.
- X-ray Computed Tomography (XCT) – XCT may be used on small samples of metallic fuel if desired.
- Micro-mechanical testing – several capabilities exist in IMCL to complete mechanical testing on small samples. These may be executed as part of the research on metal fuels.
- Other IMCL capabilities may be used in accordance with their operating procedures.

The scope of work that takes place during PIE on these metallic fuels that takes place in Analytical Lab generally includes the following activities, using the capabilities and functionalities in the containments and hot cells:

- Burnup analysis – to analyze burnup of these fuels, the fuel material is dissolved in acid, chemically separated, and analyzed using mass spectrometry.
- Hydrogen analysis – in the future, analysis of hydrogen content may be completed on these fuel and cladding materials. The Hydrogen analyzers in the glove boxes and the new hydrogen analyzer in the hot cell may be used to complete this analysis.

Work to characterize fresh (non-irradiated) specimens may occur at the Sample Preparation Laboratory (SPL) in the future, however the facility is not functional yet, so scope is yet unknown for this facility. Since these fuels are irradiated, and since SPL is a non-alpha facility, no Post-irradiation exams of irradiated material are expected to be completed in SPL.

Several other, smaller examinations on fresh fuel may be completed in the FASB facility. This is typically for thermal properties measurements using fresh material and existing instruments and processes.

The Center for Advanced Energy Studies (CAES) may be used to study small amounts of irradiated material, typically in the form of APT needles and TEM lamella; these are on the orders of tenths of milligrams of these materials or less. Shipment of these materials to CAES is controlled by existing processes.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Project activities have the potential to generate radioactive emissions.

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

NA

Generating and Managing Waste

When wastes are generated, how they are disposed can adversely affect the environment. Managing wastes appropriately and responsibly and implementing recycling or reuse practices, where feasible, during project activities can reduce the potential impact on the environment.

The estimated waste generation volume for each applicable waste type associated with the Metallic Fuel Post Irradiation Examination for Legacy Material:

Industrial (PPE/gloves) Waste: 20 gal/yr
Transuranic Waste (> 100nCi/g): 2 gal/yr
Low-Level Waste: 10 gal/yr
Radioactive Waste: 1 gal/yr

Releasing Contaminants

NA

Using, Reusing, and Conserving Natural Resources

NA

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.

References: B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

For the DOE procedures regarding categorical exclusions, including the full text of each categorical exclusion, see 10 CFR 1021.102 and Appendix B to 10 CFR Part 1021, and also Section 5.4 (Applying one or more categorical exclusions to a proposal) and Appendices B and C of DOE's National Environmental Policy Act Implementing Procedures (June 30, 2025). Requirements and guidance in 10 CFR 1021.102 and DOE's NEPA Implementing Procedures: (See full text in regulation and in Implementing Procedures)

The proposal fits within a class of actions that is listed in Appendix B to 10 CFR Part 1021 or Appendix B and C of DOE's NEPA Implementing Procedures (June 30, 2025).To fit within the classes of actions listed in Appendix B to 10 CFR Part 1021, or Appendix B of DOE's NEPA Implementing Procedures, a proposal must satisfy the conditions that are integral elements of the classes of actions in Appendix B of both 10 CFR Part 1021 and DOE's NEPA Implementing Procedures.

There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal. DOE or an applicant may modify the proposal to avoid reasonably foreseeable adverse significant effects such that the categorical exclusion would apply.

The proposal has not been segmented to meet the definition of a categorical exclusion.

[Note: For proposals that fit within the categorical exclusions listed in Appendix C of DOE's NEPA Implementing Procedures, see DOE's notice of adoption for the subject Appendix C categorical exclusion for additional considerations. DOE notices of adoption for other agency categorical exclusions may be found on DOE's Section 109 webpage.]

Based on my review of the proposed action, as NEPA Compliance Officer, I have determined that the proposed action fits within the specified class(es) of action, the other requirements and guidance set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

Approved by Robert Douglas Herzog, DOE-ID NEPA Compliance Officer on: 7/1/2025