DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-16-009 R1

SECTION A. Project Title: United States (U.S.) High Performance Research Reactor Fuel Development Post Irradiation Examination

SECTION B. Project Description and Purpose:

Rev 3
The purpose of the third revision is to 1) update the Project Description with corrections to the program name changes, 2) to add in-town Research and Development (R&D) facilities, and 3) to differentiate methods of post-irradiation examination (PIE), Fresh Fuel Studies, or both. In summary, this revision adds the examination of fresh fuels at Idaho National Laboratory (INL) Research Center (IRC). Fresh Fuel examination would not occur at Hot Fuels Examination Facility (HFEF).

The purpose of this work is to support the United States (U.S.) Department of Energy (DOE) U.S. High Performance Research Reactor (USHPRR) Program (herein referred to as the Program). This program has formerly been known as the U.S. Department of Energy /National Nuclear Security Administration (NNSA) Global Threat Reduction Initiative's (GTRI's) Reactor Conversion program, and formerly the Reduced Enrichment for Research and Test Reactors (RERTR) program. The Program minimizes the use of highly enriched uranium (HEU) in civilian applications by providing governments and facilities around the world with technical and economic assistance to convert research reactors to the use of non-weapons-usable low enriched uranium (LEU) fuels. The Program's mission is to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. The Program achieves this mission through three complementary initiatives:

1. Convert research reactors and radioisotope production facilities from the use of HEU to LEU
2. Remove and facilitate disposition of excess nuclear and radiological materials
3. Protect high priority nuclear and radiological materials from theft and sabotage.

In instances where suitable LEU fuels do not exist for particular reactors to convert, the Program contributes to the development of new LEU fuels. As no suitable LEU fuel is currently available with which these reactors could convert, the Program is developing a new high density LEU fuel and fabrication capability to allow for these conversions. The proposed action uses facilities at the Idaho National Laboratory's (INL's) Materials and Fuels Complex (MFC), Advanced Test Reactor Complex, and in-town facilities such as INL Research Center (IRC) to support research and development (R&D) activities in support of LEU fuel development for the Program, and proposed activities are consistent with current facility operations.

Research and development activities for this LEU fuel are comprised of four segments that would be integrated until a qualifiable fuel has been developed. The four segments are Fabrication, Fresh Fuel Testing (FF), Irradiation and Post Irradiation Examination (PIE).

USHPRR fuel plates are fabricated primarily at the Fuels and Applied Science Building (FASB) (MFC-787) at MFC. Some experiments require a collaborative effort with fuel plates and plate materials being manufactured at Y-12 at Oak Ridge National Laboratory, Argonne National Laboratory East, Los Alamos National Laboratory (LANL) and the Pacific Northwest National Laboratory (PNNL). After fabrication, the fuel plates are transported to MFC and then possibly to the IRC for initial Fresh Fuel studies or to the INL's Advanced Test Reactor (ATR) for irradiation. After irradiation, the plates are shipped to MFC for PIE. Fresh fuel examination may include depleted uranium, low-enriched uranium, and/or high enriched uranium.

Fresh Fuel studies and PIE are essential components of the fuel development effort in that it provides data on plate irradiation performance that feeds back to fabrication variables and provides data to help qualify the down-selected fuel system that meets performance requirements. The following Fresh Fuel activities may be conducted at MFC or IRC and PIE activities are conducted at HFEF.

1. Visual Examination (FF and PIE)

The visual examinations of plates at HFEF are performed to identify any anomalies, changes or defects that may have occurred during irradiation or shipping. The examination is performed using a telephoto lens and camera, taking photos through the HFEF hot cell window. Photographs are taken of the front, back, and end of all capsules. This is a non-destructive examination of the fuel plates.

2. Disassembly Modeling (PIE)

Disassembly of the capsules is done only to remove the fuel plates from the capsules themselves. Every effort is made to do so without damaging the fuel plates. This is a non-destructive examination of the fuel plates.

3. Gamma Scanning (PIE)

All irradiated experimental plates are scanned using the precision gamma scanner (PGS) in both the transverse and axial directions. Gamma scan results are used to determine the relative 2-D fission density gradient over a plate. This is a non-destructive examination of the fuel plates.

4. Immersion Density (PIE)

The immersion density data provides fuel swelling values for the entire plate. This information is used in the fuel qualification report as a fundamental fuel behavior property. This is a non-destructive examination of the fuel plates.

5. Eddy Current (Oxide) (PIE)

Eddy current measurements are taken to estimate the oxide thickness that has grown on the fuel plates. This is a non-destructive examination of the fuel plates.

6. Profilometry (PIE)

Profilometry data is used to determine local fuel swelling and is vital to the fuel qualification report. This is a non-destructive examination of the fuel plates.

7. NRAD (PIE)

Neutron radiography is performed to identify any cracking in the fuel foil prior to sectioning. This is a non-destructive examination of the fuel plates.

8. Metallography (PIE)

Metallography is both a qualitative and quantitative measure. This is a destructive examination of irradiated plates requiring sectioning and mounting small pieces of the irradiated fuel plate for examination in the microscope.

9. Microhardness (FF and PIE)

Microhardness testing is done on the system installed in the HFEF met box. This is a destructive examination of irradiated plates requiring sectioning and mounting small pieces of the irradiated fuel plate.

10. Blister Anneal Testing (PIE)

This test requires that the fuel plate be heated to the point where the first failure threshold has been reached as indicated by raised areas (blisters) on the surface of the fuel plate. This is required for fuel qualification since blistering is conservatively presented as a precursor to a breach of the fuel cladding, the primary containment of the fuel and fission products. Blister anneal testing can be performed in simple furnaces provided the temperatures can reach a maximum of 550°C. This is a destructive examination of irradiated plates.

11. Burn-up and Scannning Electron Microscope (SEM)/Transmission Electron Microscope (TEM) Sample Preparation, Clad Dissolution, Sample Measurements, and Bend Testing (PIE)

Sample preparation involves sectioning of irradiated plates, packaging and transferring of materials to the appropriate MFC facility, such as the Electron Microscopy Laboratory and Analytical Laboratory. This is a destructive examination of irradiated plates.

Also included is dissolution of aluminum cladding from the samples using a solution of NaOH. Dimensional measurements will be conducted on each sample. Mechanical testing would be performed in the load test frame in HFEF.

12. Fission Product Release (PIE)

Data obtained from fission gas release may be used in the fuel qualification report. The purpose is to identify the failure thresholds and measure fission product release to define the allowable safety margins for U-Mo monolithic and dispersion fuel utilization. Specifically source term data is determined based on the type and movement of various fission product inventories. This is a destructive examination of irradiated plates. These exams can be performed in a furnace that can accommodate the sample size and that is capable of reaching at least 2000°C. This is a destructive examination of irradiated plates.

13. Residual Stress (FF & PIE)

Residual Stress measurements are used to provide information about post irradiation mechanical state and plate failure mechanisms. Testing involves incremental slitting of fuel plates combined with plate deflection measurements.

14. Laser Shock Bond Strength Testing (FF & PIE)
Bond Strength measurements are used to assess the relative strength of cladding-to-fuel bonding in irradiated fuel plates. Testing involves using laser generated shock waves to de-bond the fuel plate and laser ultrasonic inspection to characterize the interfaces.

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 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). 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 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

Rev 2
The purpose of the first revision to this environmental checklist (EC) (see INL-13-039 R1) was to capture the work activities and environmental aspects of additional Post Irradiation Examination (PIE) activities, specifically dissolution of aluminum cladding and bend testing in the Hot Fuels Examination Facility (HFEF). Additionally, an addendum was added to EC INL-13-039 R1 dated March 4, 2015 to address fabrication of hardware and test elements at in-town or INL Site facilities.

The purpose of this second EC revision is to add residual stress measurements and bond strength measurements to the project scope as described later in this EC.

The purpose of this work is to support the U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA) Global Threat Reduction Initiative's (GTRI's) Reactor Conversion program (herein referred to as the Convert Program) which minimizes the use of highly enriched uranium (HEU) in civilian applications by providing governments and facilities around the world with technical and economic assistance to convert research reactors to the use of non-weapons-usable low enriched uranium (LEU) fuels. GTRI's mission is to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. GTRI achieves this mission through three complementary initiatives:

1. Convert research reactors and radioisotope production facilities from the use of HEU to LEU
2. Remove and facilitate disposition of excess nuclear and radiological materials
3. Protect high priority nuclear and radiological materials from theft and sabotage.

In instances where suitable LEU fuels do not exist for particular reactors to convert, the Convert Program contributes to the development of new LEU fuels. As no suitable LEU fuel is currently available with which these reactors could convert, the Convert Program is developing a new high density LEU fuel and fabrication capability to allow for these conversions. The proposed action uses existing facilities at the Idaho National Laboratory's (INL's) Materials and Fuels Complex (MFC) to support research and development (R&D) activities in support of LEU fuel development for the Convert Program, and proposed activities are consistent with current facility operations.

Research and development activities for this LEU fuel are comprised of three segments that would be integrated until a qualifiable fuel has been developed. The three segments are Fabrication, Irradiation and Post Irradiation Examination.

Reduced Enrichment for Research and Test Reactor (RERTR) fuel plates are fabricated primarily at the Fuels and Applied Science Building (FASB) (MFC-787) at MFC. Some experiments require a collaborative effort with fuel plates and plate materials being manufactured at Y-12 at Oak Ridge National Laboratory and Argonne National Laboratory East. After fabrication, the fuel plates are transported to the INL's Advanced Test Reactor (ATR) for irradiation. After irradiation, the plates are shipped to MFC for post irradiation examination (PIE) at Hot Fuel Examination Facility (HFEF) (MFC-785).

PIE is an essential component of the fuel development effort in that it provides data on plate irradiation performance that feeds back to fabrication variables and provides data to help qualify the down-selected fuel system that meets performance requirements. The following PIE activities are conducted at HFEF:

1. Visual Examination

The visual examinations of plates at HFEF are performed to identify any anomalies, changes or defects that may have occurred during irradiation or shipping. The examination is performed using a telephoto lens and camera, taking photos through the HFEF hot cell window. Photographs are taken of the front, back, and end of all capsules. This is a non-destructive examination of the fuel plates.

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11. Burn-up and SEM/TEM Sample Preparation, Clad Dissolution, Sample Measurements, and Bend Testing

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Also included is dissolution of aluminum cladding from the samples using a solution of NaOH. Dimensional measurements will be conducted on each sample. Mechanical testing would be performed in the load test frame in HFEF.

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13. Residual Stress

Residual Stress measurements are used to provide information about post irradiation mechanical state and plate failure mechanisms. Testing involves incremental slitting of fuel plates combined with plate deflection measurements.

14. Bond Strength measurements are used to assess the relative strength of cladding-to-fuel bonding in irradiated fuel plates. Testing involves using laser generated shock waves to de-bond the fuel plate and laser ultrasonic inspection to characterize the interfaces.

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 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). 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 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 HFEF. 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. 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.

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

Generating and Managing Waste

Small amounts of low-level, mixed low-level, industrial waste and hazardous waste may be generated (estimated at ~2 ft3 per week) from personal protective equipment and towels used for cleaning and polishing. Irradiated sample debris and PIE waste are expected to generate research and development-related TRU waste and mixed TRU waste. Irradiated sample debris and secondary waste could total as much as 20-30 Kg. When dispositioned as waste, the irradiated sample debris and PIE material will likely be categorized as TRU and potentially MTRU waste. 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...". Project personnel would work with WGS and/or BEA waste management staff to characterize and properly disposition the waste.

Fresh fuel examination is expected to generate small amounts of industrial waste such as wipes, PPE, scrap metal, and non-contact cooling water. All Solid waste will be managed by WGS. Scrap metal will be recycled to the extent practicable. Non-contact cooling water will comply with Idaho Falls sewer regulations.

Releasing Contaminants

Very small amounts of radioactive material may be emitted during the course of this work. Airborne and liquid releases will not exceed historical values associated with normal operation of the HFEF facility.

Using, Reusing, and Conserving Natural Resources

All materials would be reused and recycled where economically practicable. All applicable waste would 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 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)

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)

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.

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: 5/10/2016