SECTION A. Project Title: Accelerated Testing of Materials in Capsules (AToMiC)

SECTION B. Project Description and Purpose:

This Idaho National Laboratory (INL) irradiation project, the Accelerated Testing of Materials in Capsules (AToMiC), is a series of Joint ExpErimental Program (JEEP) experiments operating within the Nuclear Energy Agency's (NEA's) Framework for IrraDiation Experiments (FIDES) second triennial. AToMiC is dedicated to the understanding of microstructural evolution of fuel materials for use in higher temperature, Generation IV (GenIV) type reactors (notionally referred to as advanced reactors). Fuel types for this project include a broad range of fuel types that are described in a phased approach where first tier priority fuel types are proposed for immediate funding within the second FIDES triennial. The first phase of AToMiC experiments will utilize existing experimental methods at the Advanced Test Reactor (ATR). These experiments will be drop-in capsule style irradiation experiments. The AToMiC experiments will utilize the Fission Accelerated Steady-state Testing (FAST) method where scaled fuel designs have been shown to achieve high burnups in fractions of the time of conventional fuel tests while still maintaining near-prototypic irradiation conditions and behaviors. The FAST method provides performance data of the advanced fuels at higher burnup. Fuels tested within the first phase of AToMiC will include metallic fuels with advanced cladding, advanced tri-isotropic structural fuel (TRISO), and advanced mixed-oxide (MOX) fuel. To compliment this test, design work will also be performed to support an instrumented testing vehicle in the High Flux Reactor (HFR) in Petten, Netherlands. The completion of this design activity will result in a follow-on irradiation phase in future triennials. The goal of the research/testing is to increase the time that advanced nuclear fuels can be used in a reactor before they need to be changed out – reactor cycles, regulated by Nuclear Regulatory Commission (NRC).

This project will be a collaboration with Ultra-Safe Nuclear Corporation (USNC), General Atomics (GA), Kairos Power, Westinghouse, and Commissariat à l'Energie Atomique et aux énergies alternatives (CEA) of France.

Work will take place at the following INL facilities:

- Design/Analysis: Engineering Research Office Building (EROB) and Willow Creek Building (WCB)
- Hardware Fabrication: North Holmes Laboratory (NHL)
- Specimen fabrication: Experimental Fuels Facility (EFF), Fuels and Applied Science Building (FASB), and Fuel Manufacturing Facility (FMF)
- Experiment storage: Test Train Assembly Facility (TTAF)
- Irradiation: ATR
- Post-Irradiation Examination (PIE): Material and Fuels Complex (MFC), Hot Fuel Examination Facility (HFEF), Irradiated Materials Characterization Laboratory (IMCL) and Analytical Laboratory (AL)

The process typically involves the following activities:

- Design & Analysis:
  - The AToMiC project will include design and analysis of an in-pile test train compatible with various ATR positions. The test train assembly will include a drop-in capsule which is well suited for creating relevant thermal conditions for irradiating fuel pins in an integral style test. Design & Analysis will be performed using relevant software for which the INL currently own licenses run on the INL High Performance Computing (HPC) system.
- Fabrication & Assembly:
  - Experiment capsule will be fabricated by INL at the NHL using existing equipment. Alloy fuel specimens (casting pins) will be fabricated at the MFC, likely in the EFF. Pre-characterization activities may take place at the AL at MFC. Other fuels that will be tested will be fabricated at other offsite facilities: MOX Pellets or discs - CEA of France, MOX - General Atomics, and TRISO compacts – (Westinghouse, USNC, Kairos Power). Assembly of the experiment will be performed at the MFC (AFF/EFF/FASB/FMF) and possibly stored at the TTAF at ATR. No special or new equipment is anticipated to be needed to perform fabrication and assembly of this experiment.
- Irradiation/Shipping:
  - The experiments will undergo irradiation in the ATR for up to 7 cycles with Advanced TRISO in summer of 2025, uranium dioxide (UO2) in silicon carbide (SiC)/SiC fiber (SiCf) in summer of 2026, Metal fuel in summer of 2026, and MOX in summer of 2026. The capsules will be removed from the ATR canal following irradiation, inserted into either the GE100 or the BRR casks, and shipped to MFC for PIE. The capsules will be received at HFEF.
- PIE:
  - After receipt of the experiment at HFEF, the fuel will undergo the following PIE activities (may vary depending on fuel type): rodlet profilometry, precision gamma scanning, neutron radiography, fission gas assessment, and metallography. Additional PIE may be identified later.

After PIE, irradiated test pin segments and PIE remnants will be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in the HFEF or the Radioactive Scrap and Waste Facility (RSWF) in accordance with DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996).Ultimate disposal of the irradiated test pin segments and PIE remnants will be along with similar DOE-owned irradiated materials and experiments currently at MFC. Categorizing this material as waste is supported under Department of Energy Order (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). 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 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 transuranic (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.

There is the potential to generate low level waste (LLW). The environmental impacts of transferring low level waste from the INL to the Nevada National Security Site were analyzed in the 2014 Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426) 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.

Tasks include:

INL (lead):

- Conceptual design description of the irradiation
- Complete fabrication of metal fuel specimen at INL
- Complete fabrication of advanced cladding materials
- Report detailing the final design and test plan for the irradiation experiment
- All quality assurance tags and a report detailing all as-built conditions
- Memo signifying to the TAG and GB that the AToMiC experiments have been inserted into the reactor
- Report with power histories on all tests
- Final report with neutron radiography, gamma spectrometry, profilometry, optical microscopy, and SEM data of irradiated specimens (as applicable)

USNC (support):

- Complete fabrication of TRISO fuel specimen and delivery to INL

GA (support):

- Complete fabrication of advanced cladding materials

Kairos Power (support):

- Complete fabrication of TRISO fuel specimen and delivery to INL

Westinghouse (support):

- Complete fabrication of TRISO fuel specimen and delivery to INL

CEA of France (support):

- Complete fabrication of MOX fuel specimen and delivery to INL

INL waste may include:

- TRU: <1m3 produced through ATR irradiation and in PIE facilities at MFC
- Mixed: potential (cadmium)
- Low level: < 5kg (experiment hardware)
- PPE, wipes: nominal
- Sample debris: Project personnel would work with WGS to characterize and properly dispose of all irradiated sample debris.

Off-site waste will be managed according to facility specific requirements.

All off-site partners will comply with their local procedures and state/federal regulations as identified in contract agreements.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

NA

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

Cultural: Pursuant to the 2023 Programmatic Agreement, the proposed actions at INL do not meet the threshold of a federal undertaking and there is no effect to historic properties.

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.

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

NA

Environmental Justice

Assuming full compliance with all pertinent regulatory frameworks, work conducted by the listed project partners is not expected to result in disproportionately high or adverse impacts on communities of environmental justice concern. The INL site is located within census tracts identified as disadvantaged by the Council on Environmental Quality Climate and Economic Justice Screening Tool. However, there is no permanent population within the boundaries of the site. Additionally, the proposed work is not anticipated to impact any of the burdens faced by the communities near the INL site. Any EJ impacts stemming from work conducted on the INL site is expected to be negligible.

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: B3.6 "Small-scale research and development, laboratory operations, and pilot projects"
DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS0203,1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996).

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Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE/EIS-200-F, May 1997).

Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426, December 2014).

Justification: JUSTIFICATION: Based on the purpose and need and description of the proposed action and potential environmental impacts, the proposed action fits within the class of actions that is listed in Appendix B CX B3.6. There are no extraordinary circumstances related to the proposed action that may affect the significance of the environmental effects of the proposal. The proposed action has not been segmented to meet the definition of a categorical exclusion. This proposal is not connected to other actions with potentially significant impacts (40 CFR 1508.25(a)(1)), is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1508.27(b)(7)) and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement.

Authorizing the proposed action will not (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including DOE and/or Executive orders; (2) require siting of new facilities or expansion of existing facilities; (3) disturb hazardous substances, pollutants, or contaminants; (4) adversely affect environmentally sensitive resources; or (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species.

After PIE, irradiated test pin segments and PIE remnants will be stored with other similar DOE-owned irradiated materials and experiments at MFC, most likely in the HFEF or the Radioactive Scrap and Waste Facility (RSWF) in accordance with DOE's Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (FEIS) and ROD (DOE/EIS0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996).Ultimate disposal of the irradiated test pin segments and PIE remnants will be along with similar DOE-owned irradiated materials and experiments currently at MFC. Categorizing this material as waste is supported under Department of Energy Order (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...".

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Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Robert Douglas Herzog, DOE-ID NEPA Compliance Officer on: 10/24/2024