

SECTION A. Project Title: Investigating Fundamental Actinyl Catalysis in Extreme Environments

SECTION B. Project Description and Purpose:

Idaho National Laboratory's (INL's) core mission is to discover, demonstrate, and secure innovative nuclear energy solutions, clean energy options, and critical infrastructure. The INL Laboratory Directed Research and Development (LDRD) program engages researchers, leadership, and infrastructure to convert scientific and engineering ideas into scientific discoveries, research capabilities, research and development (R&D) programs, and deployed technology solutions. INL uses the LDRD program to develop core capabilities and achieve strategic initiatives in science and technology. This project will be covered under initiative 6.1 Emerging Core Capabilities: Chemical and Molecular Science: Chemical Kinetics and Reaction Dynamics.

The use of actinide elements is a promising strategy for accessing desirable chemical transformations. The proposed research will determine the unprecedented feasibility of actinide catalysis and photocatalysis in extreme radiation environments to study unexplored electron transfer reactions and elucidate actinide periodic trends. The knowledge gained may advance actinide science, provide mechanistic understanding for important catalytic processes, and support technological innovation in global nuclear energy by developing sustainable uses for underutilized constituents of used nuclear fuel. The project will not be using actual used nuclear fuel, it will use stocks of neptunium-237 already in the Material and Fuels Complex (MFC) Radiochemistry Laboratory (RCL).

This work will involve three main project steps of the study of hydrocarbon oxidation:

- Reactions using actinide elements in aqueous solution under mild conditions,
- Reactions using actinide elements in aqueous solution under intense light irradiation, and
- Reactions using actinide elements in aqueous solution under ionizing (alpha and gamma) radiation and light, which will utilize the Nordion Gamma Cell in the Fuels and Applied Science Building (FASB) and fiber optic cables (purchased by the project) that may be used following the end of the project in other research.

The experimental work will be supplemented by computational studies that model the chemical mechanisms at play alongside the electronic structures of actinide catalysts. Computational studies will be carried out using the INL's High Performance Computing (HPC) facilities. The experimental work will be completed at the MFC at INL, specifically making use of the RCL and gamma irradiation facilities in FASB. Actinide solutions containing organic products will be analyzed before and after catalytic reactions (and irradiation) using an Agilent Cary 6000 Ultraviolet-Visible (UV-Vis) spectrophotometer and by gas chromatography-mass spectrometry (GC-MS) in the MFC RCL. Following analysis, samples containing transuranic elements will be reprocessed to recover these materials for reuse.

Waste may include:

- 1 mL to 1 L of organic Solvent and aqueous acidic solutions
- Standard amounts of PPE, wipes, plastic containers and glass vials
- 1 mL of organic and aqueous waste
- Transuranic material will be removed from samples for reuse, the remaining sample will be disposed as low level waste.

The project does not include any off-site work or partnerships.

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, this federal undertaking is excluded from Section 106 review and the proposed activity results in no historic properties affected.

Generating and Managing Waste

1 mL to 1 L of organic Solvent and aqueous acidic solutions. Standard amounts of PPE, wipes. Standard amount of personal protective equipment, wipes, plastic containers and glass vials, 1 mL of organic and aqueous waste. TRU material will be remove from samples for reuse, the remaining sample will be disposed as low level waste.

DOE-ID NEPA CX DETERMINATION
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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

According to the CEQ Climate and Economic Justice Screening Tool, the INL site as well as the Research and Education Campus in Idaho Falls, ID are located in U.S. Census tracts that are identified as disadvantaged communities. Census tracts identified as disadvantaged meet or exceed socioeconomic, environmental, health, or demographic thresholds identified by CEQ. Given that activities analyzed in this document will happen within the boundaries of existing DOE/INL land and/or facilities where there are no permanent residents, any impacts to Environmental Justice in surrounding communities are anticipated 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"

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.

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: 8/15/2024