

SECTION A. Project Title: Chemical Interaction and Compatibility of Uranium Nitride Fuels with Liquid Pb and Alumina-forming Austenitic Alloys – Rensselaer Polytechnic Institute
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SECTION B. Project Description

Rensselaer Polytechnic Institute (RPI) proposes to study critical data for fuel-coolant-cladding chemical interaction and compatibility for uranium nitride (UN), liquid lead (Pb), and alumina-forming austenitic alloys (AFAs). UN powder will be fabricated into fuel pellets and exposed to liquid Pb in a lead-cooled fast reactor (LFR). The testing parameters for the chemical interaction investigation will be from 550 to 750 °C for 500 and 1000 hours while the oxygen content in the liquid Pb will be held between 10⁻⁸ and 10⁻⁵ wt%.

After chemical interaction, the UN pellets, AFAs and solidified Pb melt will be retrieved for post interaction characterization using various materials characterization and elemental analysis approaches. Particularly, X-ray diffraction will be used to study possible new phase formation. Scanning electron microscopy (SEM), focused ion beam (FIB), and transmission electron microscopy (TEM) characterizations along surface and cross-sectioned samples will be used to characterize the microstructure evolution. Energy-dispersive X-ray measurement (EDX) and electron probe microanalysis (EPMA) will be used to analyze elemental redistribution and transport. An ICP-mass spectroscopy (ICP-MS) will be used to detect any possible release of actinides (*e.g.*, U) and possible dissolution of the alloying elements of AFAs into the Pb melt.

SECTION C. Environmental Aspects / Potential Sources of Impact

Radioactive Material Use / Radioactive Waste Generation – RPI's Radiation Safety Office (RSO) has approved the PI's laboratory for storage and use of depleted uranium under RPI's license issued by the New York State Department of Health, and is monitored on a regular basis by RPI's Radiation Safety Officer. Experiments to be conducted will involve handling depleted uranium-containing samples and preparation of such for characterization and testing. Samples will be stored in the environmental controlled glovebox and waste will be disposed of following the guidance of RPI RSO. The procedures in handling, processing and sintering uranium-containing dense pellets have been established and approved by RPI RSO.

SECTION D. Determine the Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.

Note: 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, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: 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 development.

Justification: The activity consists of an investigation into the interactions between fuel, coolant, and cladding.

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

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on 7/21/2020