DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-061

SECTION A. Project Title: Plasma-Bubble Spectroscopy: A Method for Real-Time Material Quantification in Molten Salts – North Carolina State University

SECTION B. Project Description

North Carolina State University proposes to establish a method for quantifying nuclear materials in molten salts using "plasma-bubble spectroscopy" (PBS). The strategy of the proposed technique is to transform small quantities of bulk molten salt into a low-density gaseous bubble using high voltage (HV) discharges in converging geometries. This molten salt bubble is then converted into a dilute plasma by means of a glow discharge, whose sharp atomic emission lines can be spectrally analyzed with sub-angstrom resolution. The proposed technique addresses several critical challenges facing materials accounting, e.g., online monitoring capability, shot-to-shot stability, optical clarity, and the possibility of uranium isotopic differentiation. The long-term vision is to enable a low-cost, high throughput device that can operate in the extreme conditions found in molten salt reactors and advanced fuel reprocessing. The proposed research will test the validity of the stated hypothesis, specifically, that the PBS technique will create a stable plasma condition that features extremely narrow spectral linewidths. The proposed research will apply the PBS technique in room temperature saline solutions for rapid bubble characterization and discharge optimization. This stage of the proposed research will explore two different electrode configurations featuring a fixed "pipe" device and a portable fiber-coupled "probe" device. The proposed research will develop a custom optical furnace that will enable molten salt experiments within an argon glovebox. Once established, a proof-of-concept demonstration of the proposed PBS devices will be conducted using molten chloride salts in the presence of a uranium surrogate of varying percentage.

SECTION C. Environmental Aspects / Potential Sources of Impact

Salts will be utilized in the proposed research including LiCl-KCl. Such salts will be commercially procured and stored in an argon glove box. Salt disposal will be performed in a fume hood and placed in appropriate containment for EH&S disposal.

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). For purposes of this category, "demonstration actions" means actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment. Demonstration actions frequently follow research and development and pilot projects that are directed at establishing proof of concept.

Justification: The activity consists of an investigation to develop a new experimental method for material quantification in molten salts by creating a glow discharge plasma within a low-density gas bubble.

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

Approved by Jason Anderson, DOE-ID NEPA Compliance Officer, on 09/02/2021.