DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-095

SECTION A. Project Title: Self-powered wireless sensor system for health monitoring of liquid-sodium cooled fast reactors – University of Notre Dame

SECTION B. Project Description

The University of Notre Dame (UND) proposes to develop self-powered wireless sensors for health monitoring of Mechanism Engineering Test Loop (METL) systems and components. The researchers develop sensors that can monitor materials degradation in liquid metal-cooled fast reactor in primary systems. The proposed solution will utilize printed self-powered wireless multimodal sensor arrays on high-risk components for sensing and monitoring with high spatial and temporal resolutions. The proposed sensors will detect degradation early, can operate in typical liquid metal-cooled fast reactor environments over extended periods of time, and can be tightly integrated on structural materials to enable structural health monitoring. The proposed strategy addresses important sensor deployment issues, such as powering the sensor and data exfiltration needs. To achieve the proposed research goal, UND will complete the following five technical objectives: (1) Design and fabricate multimodal sensor array for real-time monitoring; (2) Design and fabricate high-temperature and high-power-density thermoelectric energy harvester; (3) Extract data from the sensors via wireless communication; (4) Demonstrate and validate sensor network at METL; (5) Develop a machine learning based digital twin of METL structures for structural health monitoring (SHM) and predictive maintenance with the objective of reducing operation and maintenance (O&M) cost. The approach proposed in this project has crosscutting significance and is applicable to any advanced reactor platform. The outcomes from this project have potential to establish a transformative sensor manufacturing method and implementation strategy to accelerate the deployment of a broad range of advanced sensors for nuclear energy applications.

SECTION C. Environmental Aspects / Potential Sources of Impact

All hazardous materials will be handled and disposed according to existing safe/standard operating procedures and waste profile forms. Chemical and hazardous waste will be generated only at laboratory scales.

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 fully functional multimodal sensors via additive manufacturing and perform a comprehensive study of these sensors through both lab bench top testing and demonstration and validation at the METL facility.

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 09/17/2021.